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TREATMENT OF TRACHOMA WITH SULFANILAMIDE

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In February 1938 Dr. Fred Loe, of Rosebud, S. D., notified us of his successful treatment of trachoma in Indian subjects with sulfanilamide, the details of which he has recently published.[1] Favorable results were also reported by Lian.[2]

After obtaining marked improvement with this treatment in certain isolated cases and rapid cure in 2 cases of experimental trachoma in baboons, we decided to test the drug on a series of persons with previously untreated active follicular trachoma in whom corneal progress could be followed by means of the slit lamp and the corneal microscope.

Accordingly, we selected 14 Apache Indian children with active follicular trachoma, 12 to be treated and 2 to be kept untreated as controls. All children had pannus and exhibited corneal activity, as evidenced by dilated pannus vessels, subepithelial infiltrates and fluorescein-staining punctate epithelial lesions. Typical epithelial cell inclusions, characteristic of active trachoma, were demonstrated in epithelial scrapings from 13 of the 14 children. Sulfanilamide in a daily dose of ⅓ grain (0.0216 Gm.) per pound of body weight, with an equal amount of sodium bicarbonate, was given in four doses during the day. The results of treatment are summarized briefly in the accompanying table.

From the Division of Health, Office of Indian Affairs, Washington, D. C., in cooperation with the Department of Ophthalmology, College of Physicians and Surgeons, Columbia University, and the Institute of Ophthalmology, Presbyterian Hospital, New York.

1. Loe, F.: Sulfanilamide Treatment of Trachoma: Preliminary Report, J. A. M. A. **111**:1371 (Oct. 8) 1938.

2. Lian, B.: Sulfanilamide in the Treatment of Trachoma, Geneesk. tijdschr. v. Nederl.-Indië **78**:1058, 1938.

Summary of Results of Sulfanilamide Therapy in a Series of Trachomatous Subjects

No., Name	Age, Sex	Stage*	Intensity†	Bacteriologic Data	Inclusions	Cornea‡	Dose of Sulfanilamide	Progress Under Treatment	Final Result; 4½ Months
1 H. H.	12 F	IIa-III	+	Normal	+	4 degrees of pannus; Herbert's pits; infiltrates; epithelial lesions	½ grain per pound of body weight per day for 43 days	Cornea rapidly became inactive; lag in conjunctival improvement	Disease arrested
2 A. T.	8 F	IIa	++	Haemophilus influenzae Diplococcus pneumoniae	+	2 degrees of pannus; infiltrates; punctate epithelial lesions	Same as for H. H.	Rapid disappearance of corneal lesions	Disease arrested; slight conjunctival hyperemia
3 S. S.	13 F	IIb, O.D. IIb-III, O.S.	+++	Diplococcus pneumoniae	+	1 degree of pannus; infiltrates; punctate epithelial keratitis, slight in right eye and marked in left eye	Same as for H. H.§	Rapid disappearance of corneal lesions	Conjunctiva smooth; slight hyperemia; slight punctate epithelial keratitis
4 K. J.	13 F	I-IIa	+++	Diplococcus pneumoniae	+	1 degree of pannus; infiltrates; slight punctate epithelial keratitis	Same as for H. H.§	Rapid disappearance of corneal lesions; lag in disappearance of conjunctival follicles	Disease arrested; slight conjunctival hyperemia
5 E. T.	13 M	IIa-III	+	Diplococcus pneumoniae Haemophilus influenzae	+	2 degrees of pannus	Same as for H. H.§	Rapid corneal response	Disease arrested; slight conjunctival hyperemia
6 N. M.	9 M	IIa-III	+	Diplococcus pneumoniae	+	2 degrees of pannus in right eye, 1 degree in left eye; infiltrates; punctate epithelial keratitis	Same as for H. H. for 41 days§	Rapid corneal response; delayed conjunctival response	Conjunctiva smooth; cornea of right eye inactive; one infiltrate in cornea of left eye
7 L. W.	10 M	I-IIa	++	Normal	+	1 degree of pannus; infiltrates; epithelial lesions	Same as for H. H. for 45 days§	Rapid corneal response; delayed conjunctival response	Conjunctiva smooth; slight hyperemia; cornea healed in right eye; slight punctate epithelial keratitis in left eye
8 L. M.	15 M	IIa-III	+	Diplococcus pneumoniae	—	2 degrees of pannus in right eye, 3 degrees in left eye; Herbert's pits; scars; infiltrates; epithelial lesions	Same as for H. H. for 41 days§	Rapid corneal improvement	Disease healed in right eye; slight conjunctival hyperemia and slight epithelial keratitis in left eye
9 R. S.	10 F	IIa	++	Normal	+	2 degrees of pannus in right eye, 1 degree in left eye; infiltrates; punctate epithelial keratitis	Same as for H. H. for 10 days§	.....	Conjunctiva healed; slight punctate epithelial lesions
10 A. T.	11 F	IIb-III	++	Haemophilus influenzae Diplococcus pneumoniae	+	3 degrees of pannus in right eye, 4 degrees in left eye; pits; infiltrates; epithelial lesions	Same as for H. H. for 19 days	Rapid corneal response; delayed conjunctival response	Disease arrested; slight conjunctival hyperemia
11 E. E.	12 F	IIa-III	± O.D. ++ O.S.	Diplococcus pneumoniae	+	2 degrees of pannus; ulcer in left eye; infiltrates; epithelial lesions	Same as for H. H. for 53 days	Rapid corneal response	Disease arrested in left eye; slight punctate keratitis in right eye
12 R. B.	12 M	I Unilateral	++	Normal	+	1 degree of pannus; infiltrates; epithelial lesions	Same as for H. H.	Rapid corneal and conjunctival response; inactive 53 days	Disease arrested
Controls									
13 J. M. J.	8 M	IIa	+++	Normal	+	2 degrees of pannus; infiltrates; epithelial lesions	None	No change	No change
14 T. J.	9 F	IIa	++	Normal	+	1 degree of pannus; limbal follicles; infiltrates; epithelial lesions	None	No change	No change

* The stage of trachoma is given according to MacCallan's classification: I, incipient; IIa, follicular hypertrophy predominant; IIb, papillary hypertrophy pre-

Striking improvement was manifest in all 12 of the treated children. The appearance of the cornea improved during the first week of treatment and was characterized by the disappearance of subepithelial infiltrations, a reduction in the caliber of the vessels of the pannus and a diminution in the number of fluorescein-staining epithelial lesions. Conjunctival improvement first became noticeable about the end of the second week of treatment and was characterized by a diminution in conjunctival secretion and a thinning and paling of the membrane. There was, however, a decided lag in the disappearance of follicles; only 1 child (no. 12) showed a normal conjunctiva at the end of the period of treatment, and in this instance the trachoma was in a very early stage. But at the time of the final examination, four and one-half months after the beginning of treatment, the conjunctivas of all 12 children were smooth and follicle free; slight hyperemia persisted in 7. At this time corneal examination with the slit lamp showed a disappearance of infiltrates in all but 1 of the 24 eyes; this eye showed a single infiltrate remaining, near the upper limbus. Noteworthy was the disappearance of epithelial lesions in all but 7 of the 24 eyes. In only 1 of the 7 were the lesions as numerous as they had been before treatment.

The 2 controls showed no definite change in the intensity of their conjunctival or corneal trachoma during the period of observation. Both were then placed on ½ grain (0.0324 Gm.) of sulfanilamide per pound of body weight per day. After three weeks the trachoma of 1 control (no. 14) had become inactive; the other (no. 13) showed considerable improvement.

The disappearance of the trachoma virus from the conjunctivas of the children treated with sulfanilamide was indicated by our repeated failure to demonstrate inclusion bodies during the period of treatment and by the failure of pooled epithelial scrapings, taken the twenty-ninth day, to infect baboons. The 2 controls, on the other hand, showed inclusion bodies when tested at weekly intervals.

No indications of toxicity other than mild headache was observed as a result of sulfanilamide therapy. No leukopenia occurred in any patient.

It is of interest that pneumococci or influenza bacilli or both were demonstrated in cultures from the conjunctivas of 8 of the 12 children. After thirty days of sulfanilamide therapy the conjunctival flora of only 3 of the 8 was normal. There was no difference in the rate of clinical improvement of the trachoma in these children and in those in whom the bacterial flora was unaffected.

COMMENT

The therapeutic effect of sulfanilamide in this series of patients was beyond question. On the basis of the appearance of the conjunctivas

alone the disease would be considered inactive in all 12 children. However, the presence of a single subepithelial infiltrate in 1 eye would seem to indicate continuing corneal activity in this instance. The significance of continued epithelial lesions without subepithelial infiltrates in 6 other eyes is difficult to evaluate, but it may be that they represent minimal trachomatous activity. In any event, sulfanilamide therapy in this series of cases proved far more rapid and effective than any other type of antitrachomatous therapy so far employed by us.

CONCLUSION

A series of 12 Indian children, all showing active trachoma with follicular hypertrophy and pannus, were treated with sulfanilamide. All showed striking improvement, and at the end of four and a half months the conjunctiva in each instance had become follicle-free and smooth. Except in 1 eye, there was a disappearance of corneal infiltrates and an apparent arrest of corneal activity. Untreated children used as controls showed no improvement during the period of observation but improved rapidly when sulfanilamide therapy was instituted. Sulfanilamide therapy caused a disappearance of the epithelial cell inclusion bodies characteristic of active trachoma.

EFFECT OF CERTAIN CHEMICAL STIMULI ON THE CALIBER OF THE RETINAL BLOOD VESSELS

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It is a matter of considerable importance to inquire into the physiologic and pharmacologic reactions of the retinal blood vessels. As Mylius [1] pointed out, these reactions are complicated, and the correlation of certain experimental findings with clinical therapy depends on a clear understanding of these responses.

The primary concern of this study of the retinal blood vessels is with the underlying forces which produce vasodilatation. This assumes therapeutic importance, as the treatment for spasm [2] and closure of the central blood vessels relates to measures which will produce immediate vasodilatation. Of the chemical agents available, acetylcholine and the nitrites have been the drugs most frequently employed. In general, these drugs produce marked relaxation of the vascular musculature with an associated drop in the systemic blood pressure.

The favorable influence of these therapeutic measures has been recorded repeatedly in the literature. Many of these accounts appear convincing, but within recent years certain discrepancies have found their way into the literature, and the observations have not always been in accord.

In an attempt to evaluate these findings it becomes expedient to rely on records which have been made by methods more accurate than ordinary ophthalmoscopic observation. This, in itself, is not an attempt to contradict personal observation but rather an endeavor to adopt a more accurate and scientific method of approach.

There are two comparatively accurate means at one's disposal for measuring the retinal blood vessels. The first, the micrometer method, gives readings which may be compared with estimates made at a later date. The second, the photographic method, is by far the more precise.

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1. Mylius, K.: Funktionelle Veränderungen am Gefäss-system der Netzhaut, Berlin, S. Karger, 1928.

2. Sedan, J., and Jayle, G. E.: Ann. d'ocul. **73**:607, 1936; **74**:6, 1937.

It is possible by this procedure to secure photomicrographs by direct microscopy; these records offer indisputable evidence of the results which occurred.

METHODS FOR MEASURING THE CALIBER OF THE RETINAL BLOOD VESSELS

All photographic procedures fall into two classes. The first is the simplest and is exemplified by the Nordenson camera.[3] This apparatus, which utilizes Gullstrand's method of reflex-free central ophthalmoscopy, is of great value in producing documentary evidence of retinal changes. The magnification, however, is limited to approximately six times, and this places a limitation on its accuracy in calibrating the retinal vessels. Despite this disadvantage, this method is the one more frequently employed clinically. In some cases it is advantageous to incorporate a micrometer scale in the picture. Simon and Goldstein [4] have described a method for doing this.

The second procedure entails the use of a planoconcave contact glass for neutralizing the optical system of the eye. This glass was first described by Koeppe [5] in 1918 and recommended for the purpose of examining the vitreous and the fundus with the slit lamp.[6] Lambert [7] in 1934 adopted this glass as an auxiliary in a new method for direct microscopy of the living eye. The mechanism, which is the only good experimental means of photographing the retinal vessels in animals, consists of a standard Leitz Ultrapak vertical illuminator mounted on an ordinary microscope barrel (fig. 1). The photographs are made by replacing the standard ocular with a miniature camera (Leica) equipped with a Leitz Micro-Ibsor lateral view finder and micrometer ocular attachment. The contact glass permits direct focusing on the retinal blood vessels, and the manipulation of this glass is facilitated by mounting it on a clear, clean glass slide. As Lambert has pointed out, the bubbles must be removed from the space between the contact glass and the cornea by the instillation of light liquid petrolatum. It is absolutely essential that all of the air be removed, since the presence of even one small bubble can completely distort the optical system and render the photographs inaccurate.

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3. Nordenson, J. W.: Hygiea **77**:1538, 1915; **87**:586, 1925. Hartinger, H.: Klin. Monatsbl. f. Augenh. **83**:579, 1929.

4. Simon, C., and Goldstein, I.: New York State J. Med. **35**:901, 1935.

5. Koeppe, L.: Arch. f. Ophth. **95**:282, 1918; **96**:232, 1918.

6. Meesmann, A.: Klin. Monatsbl. f. Augenh. **66**:417, 1921. Koeppe, L.: Arch. f. Ophth. **109**:454, 1922.

7. Lambert, R. K.: A Method for the Study of the Retinal Circulation, Arch. Ophth. **12**:868 (Dec.) 1934.

The actual technic of photography is not difficult after the contact glass is in place. The image is focused by slowly lowering the tube, and the sharp focus of the image in the viewing telescope corresponds to a similar focus on the photographic plate. The lateral view finder permits observation during the exposure.

The nonphotographic procedures depend on estimating the caliber of the retinal blood vessels by comparing them with a standard graticule scale or by utilizing either a split prism or a micrometer ocular. The graticule was first described by Neame [8] in 1936. It is advocated for use with the ophthalmoscope, and vessels as small as 0.075 mm. can be compared on the projected scale. The split prism ocular was first adapted to the slit lamp by Goldmann [9] and introduced into ophthalmology by Hendriksson [10] in 1924. This device gives a means of comparing the caliber of the vessels with the diameter of the disk. In the hands of Lobeck [11] it appears to be more accurate than the direct reading scale of the micrometer ocular.

REVIEW OF LITERATURE ON THE REACTIONS OF THE RETINAL BLOOD VESSELS

The methods which have been used to alter the caliber of the retinal blood vessels fall into two classes: chemical and physical. In this work an attempt has been made to investigate experimentally the nature of these reactions by the administration of certain drugs and to present the proof in the form of photomicrographs taken of the vessels in the living animal.

Epinephrine.—Epinephrine is a powerful sympathomimetic drug. It produces vasoconstriction by peripheral stimulation of the smooth muscle in the arteries, veins and capillaries. This response is relatively greater in the arterioles because of the abundance of smooth muscle. It has been shown that the constricting action on the pulmonary [12] and coronary [13] arteries is weak and that in the living animal these vessels usually dilate passively with the increased blood pressure. Forbes,[14] Wolff [15] and

8. Neame, H.: Tr. Ophth. Soc. U. Kingdom **56**:155, 1936.
9. Goldmann: Ztschr. f. Augenh. **78**:89, 1932.
10. Hendricksson, V.: Hygiea **86**:887, 1924.
11. Lobeck, E.: Arch. f. Ophth. **133**:152, 1935; **136**:439, 1937.
12. Ward, H. C., Jr.: J. Exper. Med. **14**:326, 1911.
13. Brodie, T. G., and Cullis, W. C.: J. Physiol. **43**:313, 1911.
14. (*a*) Forbes, H. S.; Finley, K. H., and Nason, G. I.: Cerebral Circulation: XXIV. A. Action of Epinephrine on Pial Vessels; B. Action of Pituitary and Pitressin on Pial Vessels; C. Vasomotor Response in the Pia and in the Skin, Arch. Neurol. & Psychiat. **30**:957 (Nov.) 1933. (*b*) Forbes, H. S., and Wolff, H. G.: III. Vasomotor Control of the Cerebral Vessels, ibid. **19**:1057 (June) 1928.
15. (*a*) Wolff, H. G.: Physiol. Rev. **16**:545, 1936. (*b*) Forbes and Wolff.[14b]

others studied the effect on the cerebral vessels. It has been generally observed that vasoconstriction occurs after epinephrine has been applied locally, and when the drug is administered intravenously the local constrictor effect is overcome and the cerebral vessels subsequently dilate. Wolff stated: "The effect of any given amount of epinephrine is the resultant of two opposing forces—a weak local constrictor action and the relatively stronger expansile action of the raised systemic arterial pressure."

The effect of epinephrine on the retinal blood vessels has frequently been reported. Hirschfelder [16] studied the retinal vessels of cats and rabbits and reported vasoconstriction with the use of epinephrine. Cohen and Bothman [17] observed rabbits ophthalmoscopically and noted that "adrenalin, administered intravenously, produced a temporary constriction of the arteries with a flushing of the veins from the beginning." Agatston [18] in 1933 reported producing spasm in the arteries of rabbits by injecting the drug; he was convinced that epinephrine is an active agent in the production of pathologic spasm.

Bailliart [19] attacked the problem in an ingenious manner. He trephined the sclera and then applied epinephrine locally through the trephine opening. Prolonged vasoconstriction occurred in the treated area.

Lambert [20] in 1935 reported the first photomicrographic studies on the effect of epinephrine in cats. He employed the technic previously described and injected the drug intravenously in various sized doses; vasodilatation occurred in a large percentage of the cases. Lambert accounted for this increase in the caliber of the vessels on the basis of a passive dilatation secondary to an increase in arterial tension.

Riser, Couadau and Mériel [21] adopted Lambert's technic in 1936, and their findings corroborate the work of both Lambert and Bailliart. In a series of 30 cats, injection of epinephrine into the carotid artery produced dilatation of the retinal vessels amounting to an increase of from 15 to 20 per cent in caliber. In a second series of 65 cats, intravenous (femoral) injections of epinephrine produced an increase of from 15 to 20 per cent in the caliber of the vessels in practically all of the animals. Constriction of the arteries was observed only when the drug was applied locally through a scleral trephine opening.

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16. Hirschfelder, A. D.: J. Pharmacol. & Exper. Therap. **6**:597, 1915.
17. Cohen, S. J., and Bothman, L.: Am. J. Physiol. **81**:665, 1927.
18. Agatston, S. A.: Am. J. Ophth. **16**:327, 1933.
19. Bailliart, M. P.: Tunisie méd. **29**:51, 1935.
20. Lambert, L.: Am. J. Ophth. **18**:1003, 1935.
21. Riser, Couadau and Mériel: Presse méd. **44**:1225, 1936.

Nitrites.—Amyl nitrite was first introduced into medicine by Brunton [22] in 1867 and recommended for the treatment of angina pectoris. This drug, together with other members of its group, produces vasodilatation by directly lessening the tone of vascular musculature. The reaction occurs peripherally, and dilatation of the coronary [23] and cerebral [24] vessels takes place in spite of the decrease in arterial tension.

Story [25] in 1899 was apparently the first ophthalmologist to describe the successful use of amyl nitrite in the treatment of embolism of the central artery of the retina. Similar successes were reported by Jennings [26] in 1911 and by Hird [27] in 1912. A more significant contribution is that reported by Imre.[28] He employed the drug in the treatment of certain chronic diseases of the fundus and explained his favorable results on the basis of vasodilatation of the retinal vessels. Procksch,[29] Deutschmann,[30] Genet [31] and others have been equally impressed with their results.

Lobeck,[11] a German worker, made use of the split prism ocular of Hendriksson and estimated the caliber of the vessels in a small series of cases. He recorded a slight increase in the diameter of the arteries and veins after the inhalation of amyl nitrite.

In 1931 Haessler and Squier [32] reported a careful piece of work in which the clinical effects of amyl nitrite were recorded with the Nordenson camera. The authors were unable to discern any relation between the caliber of the retinal vessels after the inhalation of amyl nitrite and the systolic blood pressure before and after the inhalation of the drug. King [33] has also observed no change in the caliber of the vessels after the inhalation of this chemical.

Lambert, in an article previously referred to, published the most convincing proof of the nature of the reaction to nitrites in cats. In a series of 6 animals there was a narrowing of the vessels, with changes

22. Brunton, T. L.: Lancet **2**:97, 1867.

23. Loeb, V.: Arch. f. exper. Path. u. Pharmakol. **51**:64, 1903.

24. (*a*) Leake, C. D.; Loevenhart, A. S., and Muehlberger, C. W.: Dilatation of Cerebral Blood Vessels as a Factor in Headache, J. A. M. A. **88**:1076 (April 2) 1927. (*b*) Florey, H. W.: Brain **48**:43, 1925. (*c*) Wolff.[15a] (*d*) Schneider, M., and Schneider, D.: Arch. f. exper. Path. u. Pharmakol. **175**:640, 1934.

25. Story, J. B.: Tr. Ophth. Soc. U. Kingdom **19**:87, 1899.

26. Jennings, R. E.: Ann. Ophth. **20**:707, 1911.

27. Hird, R. B.: Ophthalmoscope **10**:370, 1912.

28. Imre, J., abstracted, Klin. Monatsbl. f. Augenh. **85**:128, 1930.

29. Procksch, M.: Klin. Monatsbl. f. Augenh. **85**:795, 1930.

30. Deutschmann, R.: Klin. Monatsbl. f. Augenh. **88**:168, 1932.

31. Genet, L.: Bull. Soc. d'opht. de Paris, May 1932, p. 329.

32. Haessler, F. H., and Squier, L. T.: Tr. Am. Ophth. Soc. **29**:254, 1931.

33. King, G. L., Jr.: Am. J. Ophth. **12**:827, 1929.

proportional to the drop in blood pressure in all save 1 animal. These changes were all recorded photographically.

Cohen and Bothman [17] described the action of glyceryl trinitrate administered intravenously to rabbits. In their series dilatation of the arteries was observed, with no change in the caliber of the veins.

Esterman,[34] Duggan,[35] Pflimlin,[36] Jaensch [37] and other clinicians have also reported favorably on the use of sodium nitrite. Esterman in a recent article stated: "The blood pressure dropped to 80/60, the retinal arteries increased to almost twice their normal size, and the obstruction disappeared within a short time."

Acetylcholine and Choline Derivatives.—Another drug which has been used extensively during the last few years is acetylcholine. It produces symptoms similar to those produced by stimulation of the parasympathetic nervous system. Studies have shown that in addition to this reaction the drug exerts a powerful vasodilator effect on the blood vessels which have no known parasympathetic innervation. It has been suggested that this chemical may be similar to the intermediate substance produced by stimulation of the parasympathetic nervous system.

Pharmacologically, the reaction of acetylcholine may be divided into two types: (1) parasympathetic, or muscarine, action, which is characterized by slowing of the heart, vasodilatation and a decrease in the level of the general blood pressure; (2) sympathetic, or nicotine, action, which results in an elevation of the blood pressure. This combination of reactions was first observed by Dale [38] in 1914; he emphasized that the muscarine activity was by far the more conspicuous. Four years later Fuhner [39] reported that small doses of physostigmine greatly increased the degree of stimulation of the parasympathetic nervous system. This observation has since been corroborated by Loewi and Navratil [40] and others, who have suggested that physostigmine probably inhibits the effect of tissue esterase on the acetylcholine. Loewi also reported abolishing this synergy with suitable doses of atropine. Feldberg and Mintz [41] have more recently confirmed this finding.

Acetylcholine was first introduced into medicine by Villaret and Justin-Besançon [42] in 1926. These clinicians claimed considerable suc-

34. Esterman, B.: New York State J. Med. **37**:296, 1937.

35. Duggan, W. F.: Vascular Basis of Tobacco Amblyopia: Treatment with Nitroscleran, Arch. Ophth. **13**:1059 (June) 1935.

36. Pflimlin, R.: Klin. Monatsbl. f. Augenh. **85**:287, 1930.

37. Jaensch, K.: Klin. Monatsbl. f. Augenh. **77**:189, 1926.

38. Dale, H. H.: J. Pharmacol. & Exper. Therap. **6**:147, 1914.

39. Fuhner, H.: Arch. f. exper. Path. u. Pharmakol. **82**:51, 1918.

40. Loewi, O., and Navratil, E.: Arch. f. d. ges. Physiol. **219**:689, 1926.

41. Feldberg, W., and Mintz, B.: Arch. f. d. ges. Physiol. **233**:657, 1933.

42. Villaret, M., and Justin-Besançon, L.: Bull. et mém. Soc. méd. d. hôp. de Paris **50**:465, 1926.

cess with this drug in the treatment of Raynaud's disease; the clinical improvement was attributed to vasodilatation.

It is generally accepted that acetylcholine dilates the cerebral vessels. Wolff [24c] found pial dilatation averaging 22 per cent in spite of an average fall in blood pressure of 69 per cent.

In the field of ophthalmology the French physicians have been the most enthusiastic. Kalt [43] in 1928 reported the first successful use of the drug in the treatment of a patient with occlusion of the central retinal artery. A more significant contribution, however, is that of Villaret, Schiff-Wertheimer and Besançon.[44] In a series of 25 clinical cases, acetylcholine was injected subconjunctivally, and their results are quoted as follows: "Dilatation of the arteries was found positive in eleven (11), five (5) more were uncertain and nine (9) were negative." Orr and Young [45] injected 8 minims (0.49 cc.) of the drug subconjunctivally and found that this quantity was sufficiently large to cause dilatation of the vessels in their case of occlusion of the central retinal artery.

Redslob [46] applied the principle of Bailliart and injected acetycholine directly into the vitreous of a patient suffering from spasm of the central retinal artery. The spasm disappeared within a short time, and no ill effects were observed following the use of this direct method of treatment. Other noteworthy contributions are those of Bailliart,[47] Villard, Dejean and Temple,[48] Rochon-Duvigneaud,[49] Gallois,[50] de Saint-Martin [51] and de Vaucleroy.[52] More recently, Parsons, McMullen and Juler [53] reported negative results with the drug in the treatment of occlusion of the central retinal vessels.

Extensive pharmacologic studies have also been made with many of the other choline derivatives. Hunt and Taveau [54] in 1911 synthesized a

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43. Kalt, M.: Bull. Soc. d'opht. de Paris, July 1928, p. 309.

44. Villaret, M.; Schiff-Wertheimer, and Justin-Besançon, L.: Compt. rend. Soc. de biol. **98**:909, 1928.

45. Orr, H. C., and Young, H. J.: Brit. M. J. **1**:1119, 1935.

46. Redslob, E.: Bull. Soc. d'opht. de Paris, March 1930, p. 143.

47. Bailliart, P.: Bull. Soc. d'opht. de Paris, June 1928, p. 245; Arch. d'opht. **46**:172, 1929.

48. Villard, H.; Dejean, C., and Temple, J.: Arch. d'opht. **49**:72, 1932.

49. Rochon-Duvigneaud: Arch. d'opht. **48**:143, 1931.

50. Gallois, J.: Bull. Soc. d'opht. de Paris, June 1931, p. 298.

51. de Saint-Martin: Ann. d'ocul. **168**:102, 1931.

52. de Vaucleroy: Arch. d'opht. **51**:116, 1934.

53. Parsons, J.: Proc. Roy. Soc. Med. **30**:300, 1937. McMullen, W. H.: ibid. **30**:300, 1937. Juler, F.: ibid. **30**:300, 1937.

54. Hunt, R., and Taveau, R. De M.: Effects of a Number of Derivatives of Choline and Analogous Compounds on Blood-Pressure, Hygienic Laboratory Bulletin 73, United States Public Health Service, 1911.

large number of these closely related compounds, and of this group acetylbetamethylcholine chloride (mecholyl) appeared to be the most promising. Menge [55] experimented with this chemical and compared its rate of disintegration in the tissues with that of acetylcholine. This work indicated that mecholyl was far more resistant to tissue hydrolysis. Various values have been given as to the comparative strength of the two drugs. Weiss and Ellis [56] have found mecholyl to be two hundred times as powerful in man; this value is probably too high. Hunt and Renshaw [57] considered the actions of the drug to be limited almost entirely to stimulation of the parasympathetic nervous system. This finding has been corroborated by Simonart [58] and others.

Mecholyl has not been used extensively in the field of ophthalmology, although numerous references are made to its miotic action.[59] Recently Myerson and Thau [60] reported dilatation of the retinal arteries after the instillation of a 1 to 10 per cent aqueous solution of the chemical. Photographic evidence is lacking.

The two other choline derivatives which should be mentioned are carbaminoylcholine (doryl) and the ethyl ester of betamethylcholine. Both of these drugs, though less potent than mecholyl, are powerful stimulants of the parasympathetic nervous system, and when they are instilled into the conjunctival sac miosis occurs.[61] There are no references in the literature concerning their effect on the retinal blood vessels.

EXPERIMENTAL STUDIES

Methods and Procedure.—The technic adopted for these studies was the same as that described by Lambert in 1934. The camera and vertical illuminator were mounted directly on a microscope barrel and attached to an upright stand, as shown in figure 1. The head rest was made with a strip of metal and secured to the base of the upright stand with a movable clamp. In order to secure uniform pictures, it was necessary to hold the contact glass with a clamp so that the under surface of the objective was parallel with it. After the concave surface

55. Menge, G. A.: J. Biol. Chem. **10**:399, 1911; **13**:97, 1912; in Hunt and Taveau.[54]

56. Weiss, S., and Ellis, L. B.: J. Pharmacol. & Exper. Therap. **52**:113, 1934.

57. Hunt, R., and Renshaw, R. R.: J. Pharmacol. & Exper. Therap. **51**:237, 1934.

58. Simonart, A.: J. Pharmacol. & Exper. Therap. **46**:157, 1932.

59. Villaret, M.; Justin-Besançon, L.; Cachera, R., and Said: Ann. de méd. **22**:385, 1932; cited in Methyl-Acetyl-Choline, Annotations, Lancet **1**:812, 1933. Hunt, R.: J. Pharmacol. & Exper. Therap. **55**:268, 1935.

60. Myerson, A., and Thau, W.: Human Autonomic Pharmacology: Effect of Cholinergic and Adrenergic Drugs on the Eye, Arch. Ophth. **18**:78 (July) 1937.

61. Applemann, M.: Compt. rend. Soc. de biol. **115**:1359, 1934. Velhagen, K., Jr.: Arch. f. Augenh. **107**:319, 1933. Comroe, J. H., Jr., and Starr, I., Jr.: J. Pharmacol. & Exper. Therap. **49**:283, 1933.

of the contact glass was filled with light liquid petrolatum and all of the bubbles were displaced, this clamp was fastened to the nearby stand. Eastman super X film was used exclusively, and all of the exposures were made at one fifth of a second with the bulb overloaded. An attempt was made to snap the pictures only at the end of expiration, as this reduced respiratory interference to a minimum. Edwald no. 12 was found to be a satisfactory developer.

Dogs were used as experimental animals and kept under deep anesthesia with intraperitoneal or intravenous injections of pentobarbital sodium. It was found absolutely necessary to select dogs with light colored fundi, weighing between 10 and 14 Kg. Simultaneous blood pressure tracings were made during some of the experiments. Canthotomy was performed on all of the animals, and bleeding was controlled with the cautery. Medication was administered subconjunctivally, retrobulbarly, subcutaneously and intravenously.

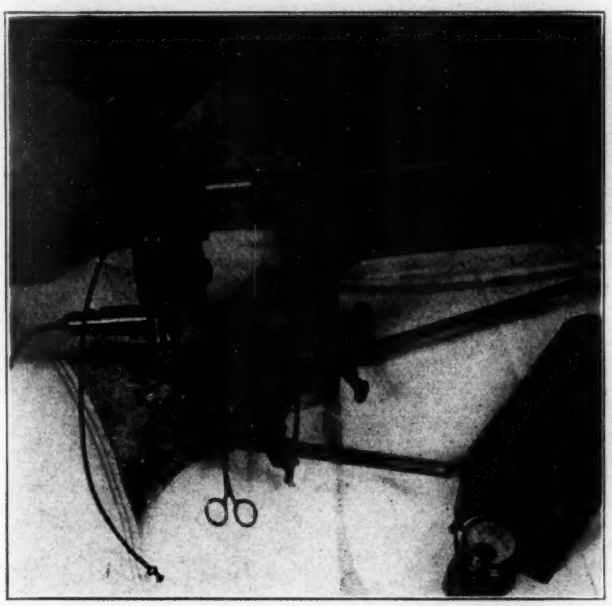

Fig. 1.—Instrument for photographing the retinal blood vessels in living animals.

RESULTS

Epinephrine.—In this part of the experimental work epinephrine hydrochloride was administered to 16 dogs (table 1). Ten animals received the medication by injection into the femoral vein, 4 by subcutaneous injection and 2 by retrobulbar injection. In 2 experiments there was a questionable increase in the caliber of the arteries (fig. 2), and in 7 the veins dilated. These reactions closely paralleled the change in blood pressure and lasted approximately three minutes. In order to study the effect of a decrease in the intraocular tension, paracentesis was performed on 2 of the dogs (fig. 3) prior to the intravenous injection

of epinephrine. Neither vasodilatation nor constriction occurred, either before or after the administration of the drug.

The retinal vessels were observed throughout each experiment by means of the viewing side arm on the Micro-Ibsor attachment. Careful records of ophthalmoscopic observation were made during this time and saved for comparison with the photographic negative. These personal observations were usually found to be inaccurate.

Fig. 2 (animal 30).—The effect of an intravenous injection of epinephrine on the caliber of the retinal vessels. *A*, before injection; *B*, after injection.

Fig. 3.—The effect of removing 3 minims of aqueous from the anterior chamber. *A*, before removal; *B*, after removal.

Nitrites.—Only 7 animals were tested in this group. Four received sodium nitrite by vein, 2 were given inhalations of amyl nitrite and 1 received glyceryl trinitrate by vein (table 2). All of these experiments gave negative results.

Mecholyl and Ethyl Ester of Betamethylcholine.—In this group mecholyl was administered to 20 dogs. Mecholyl chloride was administered to 13 animals by injections into the femoral vein, to 1 by subcutaneous injection and to 1 by retrobulbar injection; 5 were given

TABLE 1.—*Effect of Epinephrine on the Caliber of the Retinal Vessels*

Animal No.	Quantity of Epinephrine Hydrochloride Administered	Caliber of Vessels in Terms of Micrometer Readings: Before Medication, Artery	Before Medication, Vein	After Medication, Artery	After Medication, Vein	Length of Time Observed, Minutes	Systemic Reaction
1	0.5 cc. of 1:10,000 sol. intravenously	2.0	4.0	2.0	4.0	20	Mild
3	1 cc. of 1:10,000 sol. intravenously	2.5	4.5	2.5	4.5	25	Mild
4	1 cc. of 1:1,000 sol. intravenously	2.0	4.0	2.0	5.0	20	Marked
5	1 cc. of 1:1,000 sol. intravenously	2.0	4.0	2.0	4.0	20	Marked
8	0.75 cc. of 1:1,000 sol. intravenously	2.0	3.5	2.0	4.0	20	Marked
9	0.75 cc. of 1:1,000 sol. intravenously	2.0	3.5	2.0	4.5	20	Marked
29	1 cc. of 1:1,000 sol. intravenously	2.5	5.0	2.5	6.0	20	Marked
30	1 cc. of 1:1,000 sol. intravenously	2.0	5.0	2.0	6.0	10	Marked
53	Paracentesis*	1.5	4.0	1.5	4.0	4	
	0.75 cc. of 1:1,000 sol. intravenously	1.5	4.0	1.5	4.0	35	Moderate
10	0.5 cc. of 1:1,000 sol. subconjunctivally	2.5	4.5	2.5	4.5	25	Mild
28	1 cc. of 1:1,000 sol. subcutaneously	2.5	5.0	2.5	5.5	30	Mild
31	1 cc. of 1:1,000 sol. subcutaneously	2.0	4.5	2.0	4.5	25	Mild
32	1.5 cc. of 1:1,000 sol. subcutaneously	2.0	4.5	2.0	4.5	30	Moderate
17	1 cc. of 1:1,000 sol. retrobulbarly	1.5	4.5	1.5	4.5	20	Moderate
27	0.7 cc. of 1:10,000 sol. retrobulbarly	2.5	4.5	2.5	5.0	25	Moderate
49	Paracentesis*	1.5	6.0	1.5	6.0	4	
	1 cc. of 1:1,000 sol. of epinephrine intravenously	1.5	6.0	1.5	6.0	Total of 60 min.	Marked
	4 mg. of mecholyl intravenously	1.5	6.0	1.0	4.5		Marked

* Paracentesis: 3 minims (0.18 cm.) of aqueous removed from the anterior chamber, followed by the injection of epinephrine hydrochloride within four minutes.

TABLE 2.—*Effect of Nitrites on the Caliber of the Retinal Vessels*

Animal No.	Quantity of Medication	Caliber of Vessels in Terms of Micrometer Readings: Before Medication, Artery	Before Medication, Vein	After Medication, Artery	After Medication, Vein	Length of Time Observed, Minutes	Systemic Reaction
2	40 mg. of sodium nitrite intravenously	2.5	4.5	2.5	4.5	25	Slight
6	80 mg. of sodium nitrite intravenously	2.0	4.5	2.0	4.5	25	Moderate
7	70 mg. of sodium nitrite intravenously	2.5	4.5	2.5	4.5	20	Moderate
11	40 mg. of sodium nitrite intravenously	2.0	4.5	2.0	4.5	25	Slight
33	1 ampule of amyl nitrite	3.0	5.0	3.0	5.0	25	Marked
35	1 ampule of amyl nitrite	2.0	5.0	2.0	5.0	30	Marked
34	3 minims of glyceryl trinitrate intravenously	2.5	5.0	2.5	5.0	25	None

TABLE 3.—*Effect of Mecholyl on the Caliber of the Retinal Vessels*

Animal No.	Quantity of Medication	Caliber of Vessels in Terms of Micrometer Readings: Before Medication, Artery	Before Medication, Vein	After Medication, Artery	After Medication, Vein	Length of Time Observed, Minutes	Systemic Reaction
36	Mecholyl chloride, 3 mg. intravenously	2.0	4.0	1.5	2.5	25	Marked
37	Mecholyl chloride, 3 mg. intravenously	2.0	5.0	1.5	2.5	25	Marked
39	Mecholyl chloride, 3 mg. intravenously	2.0	4.0	1.5	3.0	30	Marked
38	Mecholyl chloride, 4 mg. intravenously	1.5	4.0	1.5	4.0	30	Marked
40	Mecholyl chloride, 4 mg. intravenously	1.5	5.5	1.0	3.0	35	Marked
41	Mecholyl chloride, 4 mg. intravenously	2.0	4.0	2.0	4.0	30	Marked
42	Mecholyl chloride, 4 mg. intravenously	2.0	3.0	1.0	1.5	30	Marked
43	Mecholyl chloride, 4 mg. intravenously	2.5	4.5	1.5	3.5	25	Marked
44	Mecholyl chloride, 4 mg. intravenously	2.0	3.0	1.5	2.0	25	Marked
47	Mecholyl chloride, 4 mg. intravenously	2.0	4.0	1.5	3.0	30	Marked
45	Paracentesis*	2.0	3.5	2.0	3.5	4	
	Mecholyl chloride, 3 mg. intravenously	2.0	3.5	1.5	2.5	45	Marked
46	Paracentesis*	2.0	3.5	2.0	3.5	4	
	Mecholyl chloride, 3 mg. intravenously	2.0	3.5	1.5	2.5	45	Marked
64	Mecholyl chloride, 10 mg. subcutaneously	2.0	4.5	1.0	3.0	45	Marked
49	Paracentesis†	1.5	6.0	1.5	6.0	4	
	Epinephrie hydrochloride, 1 cc. 1:1,000	1.5	6.0	1.5	6.0	Total of 60 min.	Marked
	Mecholyl chloride, 4 mg. intravenously	1.5	6.0	1.0	4.5	Total of 60 min.	Marked
16	Mecholyl chloride, 5 mg. retrobulbarly	1.5	4.0	1.5	4.0	20	Marked
48	Ethyl ester of betamethylcholine, 8 mg. intravenously	1.5	3.0	1.5	3.0	30	Moderate
50	Ethyl ester of betamethylcholine, 10 mg. intravenously	2.0	4.5	2.0	4.5	30	Moderate

* Paracentesis: 3 minims of aqueous removed from the anterior chamber, followed by the injection of mecholyl within four minutes.

† Paracentesis: the same as with animal 49 in the experiment with epinephrine hydrochloride.

TABLE 4.—*Effect of Subconjunctival Injection of Mecholyl on the Caliber of the Retinal Blood Vessels*

Animal Number	Quantity of Mecholyl Bromide Injected Subconjunctivally, Mg.	Caliber of Vessels in Terms of Micrometer Readings: Before Medication, Artery	Before Medication, Vein	After Medication, Artery	After Medication, Vein	Length of Time Observed, Minutes	Systemic Reaction
56	6	1.5	3.5	2.0	4.5	35	Moderate
59	8	2.0	4.0	2.0	4.0	40	Moderate
60	8	2.0	4.5	2.0	4.5	35	Moderate
61	8	1.5	4.0	1.5	4.0	30	Moderate
62	10	2.0	5.0	2.0	5.0	30	Marked

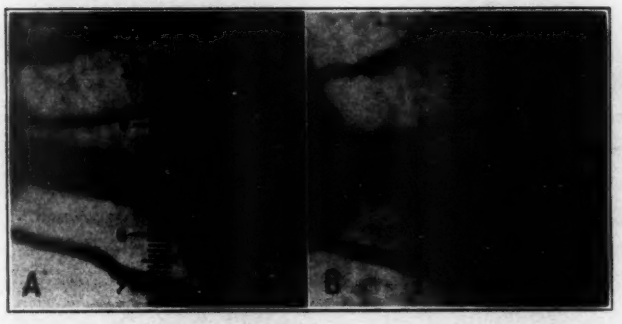

Fig. 4 (animal 37).—The effect of an intravenous injection of mecholyl on the caliber of the retinal blood vessels. *A*, before injection; *B*, after injection.

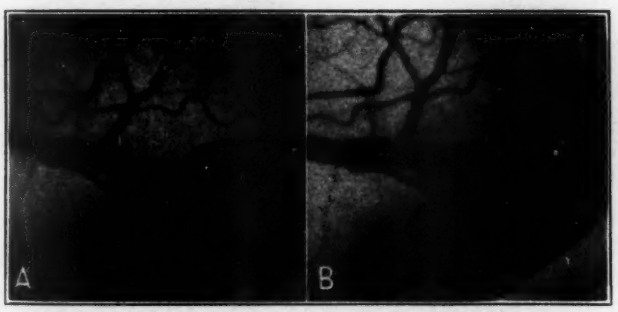

Fig. 5 (animal 56; table 4).—The effect of a subcutaneous injection of mecholyl on the caliber of the retinal blood vessels. *A*, before injection; *B*, after injection.

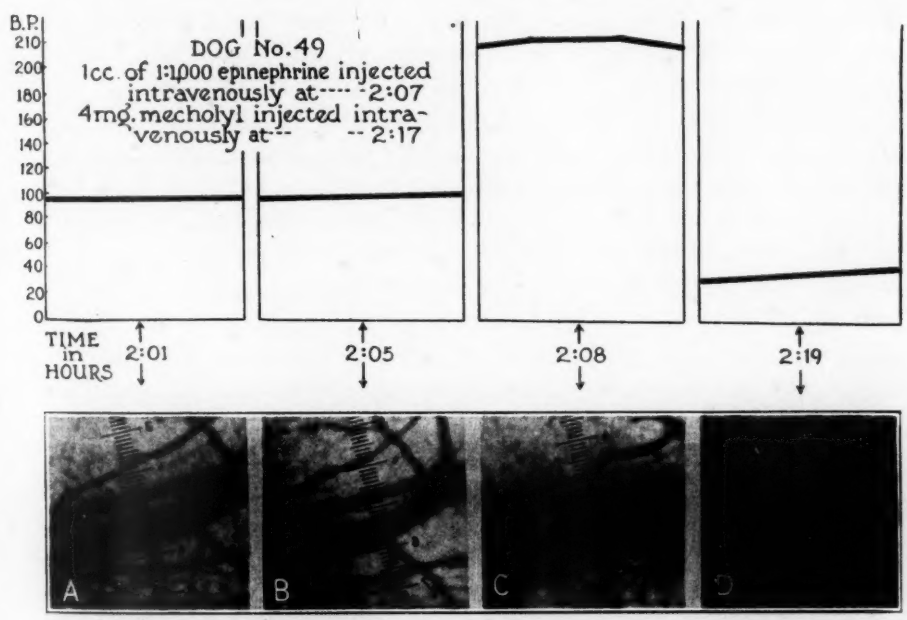

Fig. 6 (animal 49).—The effect of paracentesis together with subsequent injections of epinephrine and mecholyl. *A*, normal appearance; *B*, after paracentesis; *C*, after injection of epinephrine; *D*, after injection of mecholyl.

mecholyl bromide subconjunctivally. The evidence presented in table 3 shows a contraction of both the artery and the vein in 11 animals after injection into the femoral vein (fig. 4) and a dilatation of the artery and vein in 1 after subconjunctival administration (table 4 and fig. 5). The vasoconstriction closely paralleled the decrease in blood pressure, and this response was not altered in 3 animals in which paracentesis was performed at the beginning of the experiment (fig. 6).

The ethyl ester of betamethylcholine was injected intravenously into 1 dog and subcutaneously into another; no change was recorded in the caliber of the vessels.

COMMENT

It is important to recall that the circulation of the eye, like that of the brain, occurs within a closed space. The walls of this space, i. e., the tunic of the eye, are elastic to only a slight degree. Since marked variations in the level of the systemic blood pressure are transmitted directly to the retinal vessels, it becomes obvious that the changes in the caliber of the retinal vessels must, of necessity, depend on one or more of the following factors: (1) histologic structure and contractile elements of the vessels, (2) changes in the intraocular pressure and (3) level of the general blood pressure.

For the study of the structure of the retinal vessels, much credit is due Friedenwald,[62] Bailliart [63] and Lambert. According to Friedenwald, the central artery of the retina, posterior to the cribiform plate, has an average internal diameter of 0.1 mm. The intima and adventitia are well formed at this level, and the internal elastic lamella is present. Like similar arteries of its size, the thickness of the media is about one-fifth the diameter of the lumen, and the muscle fibers are easily discernible. The internal caliber of the vessel remains the same as it passes through the cribriform plate, but the thickness of the wall of the vessel is abruptly reduced to less than one-half its former thickness. Likewise, the intima and the internal elastic lamella are reduced to single layers and later disappear beyond the primary branches. The media are reduced to about 10 microns, and histologically it is difficult to demonstrate contractile elements. Similarly, it has been shown by Schäfer [64] that the veins of the retina resemble capillaries and consist of a single layer of endothelial cells without musculature.

There is little doubt but that the atonic veins reflect passively the fluctuations in the general blood pressure. The arteries, however, are

62. Friedenwald, J. S., in Cowdry, E. V.: Arteriosclerosis, New York, The Macmillan Company, 1933, p. 363.

63. Bailliart, P.: The Retinal Circulation, Chicago, Professional Press, Inc., 1928.

64. Schäfer, quoted by Bailliart.[63]

capable of contraction, because spasm of the central artery is frequently encountered. These spasms are possibly caused by stimulation of the contractile cells of Rouget. It is also possible that certain of these cells may be differentiated and possess the power of dilatation. All these things are without proof, but if such reactions do take place, they must necessarily occur when there is a certain degree of equilibrium established between the intraocular and the arterial tension. It is not inconsistent to believe that sharp shifts in this equilibrium could completely mask the feeble actions of such cells.

It is known that there is an intimate relation between the fluctuations of the general blood pressure and the intraocular tension. In ordinary experimental work these reactions parallel each other, but recently it has been shown by Duke-Elder [65] that there is a certain degree of dissociation between these reactions. This dissociation is demonstrated by the effect of amyl nitrite. After inhalation of this drug there is a sharp drop in systemic blood pressure, with an increase in intraocular tension, which is apparently caused by dilatation of the capillary bed.

The complexity of these reactions has also been shown by Duke-Elder following the use of epinephrine. Epinephrine in small doses (1 cc. of a 1:10,000 solution) or in doses sufficiently large to cause a rise in blood pressure, results in an increase in intraocular tension. With large doses (1:1,000 solution) there is a marked elevation of general blood pressure, and intraocular tension decreases. The lowering of the intraocular tension, in the face of increased arterial pressure, is explained on the basis of vasoconstriction of the capillary bed of the choroid.

Duke-Elder has likewise shown the effect of acetylcholine on the intraocular tension. With small doses this drug produces a decrease in intraocular as well as in arterial tension, but with large doses the intraocular tension rises secondarily to a contraction of the extraocular muscles. When tenotomy is performed on the rectus muscles, the ocular tension drops.

The relation of these complex reactions to this experimental work is clarified by recognizing that under normal conditions all of these variable forces exist within a closed space in a state of equilibrium. The two most important opposing forces within this equilibrium are arterial tension and intraocular pressure. Passive dilatation occurs when the arterial tension is markedly increased and the intraocular tension lags behind.

Thus, in the experiments with epinephrine the vasodilatation occurred at the crest of the rise in blood pressure. As Duke-Elder has shown, this reaction was probably facilitated in some cases by a decrease in ocular tension, but the relatively greater incidence of negative

65. Duke-Elder, S.: Recent Advances in Ophthalmology, Philadelphia, P. Blakiston's Son & Co., 1934, p. 115.

response, even in the face of paracentesis, certainly speaks in favor of a maximal dilatation of the vessels at the time the medication was administered. It does not seem logical to suppose that the inherent contractile forces played any part in these negative responses, since the small doses of epinephrine and the retrobulbar injections brought about no constriction of the vessels. The foregoing results and considerations confirm the work of Lambert and of Riser, Couadau and Mériel.

A reversal of the forces within this equilibrium tends to produce vasoconstriction. In the case of the nitrites the negative responses were possibly caused by insufficient doses of the drug. Since tracings were not made of the blood pressure in the experiments in which the nitrites were used, it is unwarranted to adduce further conclusions.

The overwhelming effect of a marked decrease in the systemic blood pressure is impressively demonstrated in the experiments with mecholyl, in which a large dose of the drug was administred either intravenously or subcutaneously. The intensity of this reaction was not impaired by paracentesis, and the spasm of the ocular muscles was at no time sufficiently great to overcome this decrease in ocular tension. These findings unquestionably refute any assumption that large doses in conjunction with paracentesis can produce vasodilatation of the retinal vessels.

In order to demonstrate expansile elements in the vessels themselves, it is necessary to have an optimum balance existing between the two aforesaid major forces. Such a balance was present in the experiments with mecholyl in which the drug was given subconjunctivally near the site of its reaction. Vasodilatation was recorded in only 1 animal in this group (fig. 5). This response apparently proves that the retinal vessels do possess a weak inherent expansile mechanism, but it is exceedingly difficult to reconcile the histologic knowledge of the structure of the vein with its increase in caliber. As in the previous experiment, the old issue of maximal dilatation caused by the anesthetic is still present. It is known that intraperitoneal injections of pentobarbital sodium produce peripheral vasodilatation. (Richter and Oughterson [66] and Gruber and Roberts [67] found dilatation of the cerebral vessels with the use of barbiturates.) The effect of pentobarbital sodium, however, on the retinal blood vessels is unknown. In this work it was impossible to invalidate this argument because of the technical difficulties associated with photography of the unanesthetized animal.

Practical Application.—So far as animal experimentation is applicable to man, this work casts doubt on the efficacy of using large doses of vasodilators for the treatment of spasm and closure of the

66. Richter, H. G., and Oughterson, A. W.: J. Pharmacol. & Exper. Therap. **46**:335, 1932.

67. Gruber, C. M., and Roberts, S. J.: J. Pharmacol. & Exper. Therap. **27**: 349, 1926.

central vessels of the retina. It must be borne in mind, however, that there was an increase in the caliber of the arteries and veins in 1 experiment with mecholyl in which the drug was given subconjunctivally, but the inherent vasodilator mechanism is so weak that vasodilatation is to be expected in only a small percentage of cases.

Physiologically, it is more sound to perform paracentesis and inject epinephrine subcutaneously, but few clinicians will subscribe to the use of doses large enough to produce this effect.

Thus, it is evident that the clinical aspect of this problem will be solved only when physicians realize that photographs constitute a more conclusive form of evidence than ordinary ophthalmoscopic observation. Until such proof is supplied, animal experiments of this nature should assume some degree of priority.

SUMMARY

Methods for photographing the retinal blood vessels have been discussed.

Experimental observations of various investigators have been cited which indicate the discrepancies in the literature concerning the responses of these vessels to epinephrine, nitrites and choline derivatives.

New photographic evidence has been presented with the following findings:

(*a*) Injections of epinephrine hydrochloride into 16 dogs produced a questionable dilatation of the artery in 2 animals, with an increase in the caliber of the veins in 7.

(*b*) Nitrites were administered to 7 dogs with negative results.

(*c*) Injections of mecholyl into 20 dogs produced a decrease in the caliber of the vessels in 11 and an increase in 1.

(*d*) Ethyl ester of betamethylcholine was injected into 2 dogs, with no response.

(*e*) No increase in the caliber of the vessels was found after paracentesis.

The efficacy of treating occlusion of the central arteries with vasodilators has been questioned.

A plea has been made for more photographic studies of the reactions of the retinal blood vessels in man.

The mecholyl used in this study was supplied by Merck & Co., Inc.

BIOMICROSCOPY OF CICATRICES AFTER IRIDECTOMY AND THE OPERATION OF ELLIOT OR OF HEINE

P. T. ARCHANGELSKY, M.D.
TASHKENT, U.S.S.R.

Theoretic investigations often precede practical successes. Sometimes, however, it is a long time before a thorough theoretic basis and an exhaustive explanation for practical successes are available. Such is the case when one tries to explain the results obtained with iridectomy and with the operation of Elliot or that of Heine.

Ophthalmologists are right in associating the reduction of intraocular tension with the structure of the filtration pillow and the postoperative cicatrix, because this is the most essential point for the solution of the problem.

However, a number of details in the structure of the pillow and cicatrix have escaped the attention of those investigators who tried to solve the problem by the macroscopic method. The same thing happened to those who approached this question with only the microscopic method.

The third method of investigation which is now available is macromicroscopy, e. i., biomicroscopy. This new method enables one to observe all the details which formerly escaped attention.

Biomicroscopic examination of cicatrices left after the operations of Elliot or of Heine revealed a conformity to the same established law that vessels developed in the region of the cicatrices. As to the disposition of these vessels, it is almost the same as that observed around a foreign body or an infiltrate.

My observations are rather similar to those published by Sondermann [1] in 1934, but the collection of my data began in 1931.

This collection embraces the data on patients operated on by the method of Elliot or of Heine. Some of the patients were subjected to iridectomy.

Notwithstanding the different methods of surgical treatment, the biomicroscopic pictures of the disposition of the blood vessels in the region of postoperative cicatrices were essentially the same.

From the ophthalmologic clinic of the Molotov's Tashkent Medical Institute, Dr. P. F. Archangelsky, director.

1. Sondermann, E.: Meine Glaukomtheorie und die Klinik des Glaukoms, Klin. Monatsbl. f. Augenh. **92**:313 (March) 1934.

This fact gives ground to the statement that in these basic methods of surgical treatment of glaucoma the mechanism of the reduction of the intraocular tension is uniform.

The biomicroscopic pictures observed follow:

CASE 1.—P., a woman aged 63, was subjected to iridectomy because of an acute attack of glaucoma in October 1934. The examination made on July 7, 1938, showed that a pillow had developed in the region of the postoperative cicatrix; blood vessels, coming from the conjunctival, the episcleral and the pericorneal network, approached this pillow and surrounded and penetrated it. The vascularity of the pillow was especially pronounced when massage was applied to the region of the postoperative cicatrix (fig. 1).

CASE 2.—G., a man aged 49, in 1934 was operated on by the method of Elliot because of chronic glaucoma. Biomicroscopic examination in 1938 showed a

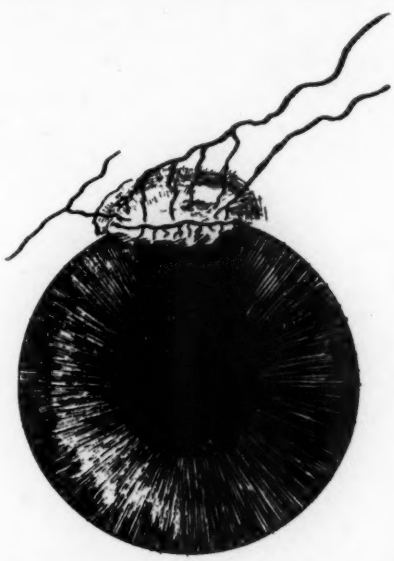

Fig. 1 (case 1).—Biomicroscopic picture of a cicatrix occurring after iridectomy.

well developed pillow pierced by blood vessels; one of these vessels produced an ampulla-like dilatation. Under low magnification the movement of the blood in this pillow reminded one of the movements of pink worms in a clod of moist soil; under high magnification the movement of erythrocytes was similar to the movements of ants in an anthill (fig. 2).

CASE 3.—N., a woman aged 40, was operated on by the method of Heine because of absolute glaucoma. Two months later biomicroscopic examination revealed that vessels with brushlike endings approached the postoperative cicatrix and surrounded it. In the angle of the anterior chamber could be seen a vessel, which left the chamber after making a loop on entering it (fig. 3).

I cite here only 3 cases, but my investigations by the biomicroscopic method embrace 50 cases in which the operation of Elliot was done, 20

Fig. 2 (case 2).—Biomicroscopic picture of a cicatrix occurring after the operation of Elliot.

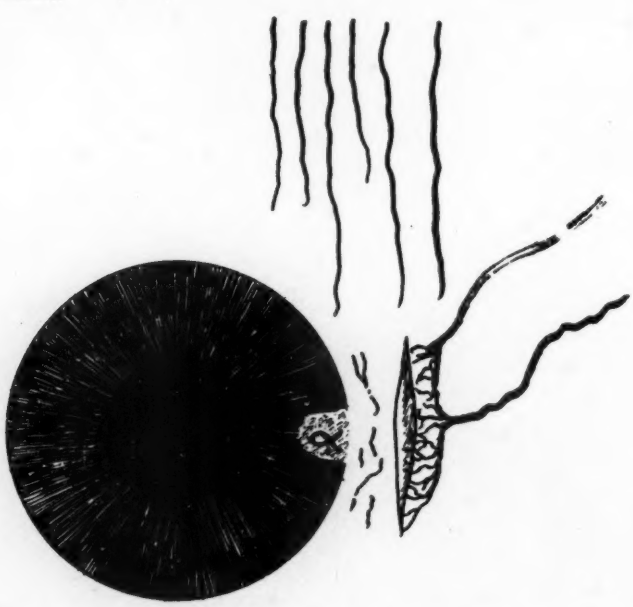

Fig. 3 (case 3).—Biomicroscopic picture of a cicatrix occurring after the operation of Heine.

in which the operation of Heine was performed and some cases in which iridectomy was employed. My observations lead to the following conclusions:

1. The disposition of the vessels developing in the region of the cicatrix left after iridectomy and after the operation of Elliot or of Heine conforms to some established law.

2. These vessels form the additional system for the outlet of intraocular fluid.

ALCOHOL-TOBACCO (TOXIC) AMBLYOPIA TREATED WITH THIAMIN CHLORIDE

LORAND V. JOHNSON, M.D.
CLEVELAND

Toxic amblyopia, with centrocecal scotomas and relatively larger scotomas for red and green, and commonly with peripheral neuritis and hypochlorhydria, appears to be generally accepted to be associated with dietary deficiencies of the vitamin B complex. The more rapid clinical improvement following the use of brewers' yeast or other forms of vitamin B [1] appears generally to be sufficiently satisfactory to cause it to be considered a routine therapeutic agent.

Admitting the multiple deficiencies from which these patients suffer, I desired to ascertain which of the vitamin B factors, if any, singly would give results most approaching the clinical improvement following the use of brewers' yeast. Thiamin chloride (B_1) and nicotinic acid appeared to be the most probable factors in the B complex and were therefore used.

CASE 1.—The first patient seen had centrocecal scotomas for red and green in each eye, a small scotoma in the left eye for white (1 mm. test object at 1,000 mm.) and vision of 20/70 in the right eye and 20/100 in the left eye. He was advised to abstain from alcohol and tobacco and to take 12 mg. of thiamin chloride daily. He cooperated well, and after five weeks the vision was 20/30.

CASE 2.—The patient had a large centrocecal scotoma (nearly 30 degrees) and considerable reduction in vision for red and green. He had been treated several times for acute alcoholism. Suggestive atrophy of the papillomacular bundle of the optic nerve was present. He was admitted to the University Hospital on Oct. 10, 1937, and was given a diet high in B vitamins and in addition 60 mg. of nicotinic acid daily. On October 24 his vision had not improved, but there was definite atrophy of the papillomacular bundle. Thiamin chloride, 12 mg. daily, was given instead of the nicotinic acid, but no improvement in vision followed. When the patient was last seen there was almost complete atrophy of the optic nerve.

CASE 3.—A gardener had been dismissed a month previously because of incompetence, it being assumed that his poor work was due to his intoxication while working. His consumption of liquor then increased in proportion to his leisure time. When he was first seen his scotomas were about 15 degrees for a

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From the Department of Surgery, Ophthalmological Service, of the Western Reserve University School of Medicine and the University Hospitals.

1. Carroll, F. D.: Importance of Diet in the Etiology and Treatment of Tobacco-Alcohol Amblyopia, Arch. Ophth. **18**:948 (Dec.) 1937.

5 mm. test object at 1,000 mm. Six weeks of abstinence plus the use of 60 mg. of nicotinic acid daily and 12 mg. of thiamin chloride daily allowed the return of vision to 20/70 and 20/100. As my supply of nicotinic acid was exhausted, the patient was advised to continue the thiamin chloride and to return to the clinic in two weeks. Instead, he returned in five weeks, stating that he had started drinking and smoking a pipe again but had continued to take the thiamin chloride until five days previously. His vision was 20/40 in each eye. He returns every month or so for additional medication. He sometimes drinks to excess. His vision remains 20/20 but with a narrow scotoma for red and green from the blindspot almost to the macula. He has been followed for six months since the recovery of vision to 20/40 and has not since reported any symptoms of peripheral neuritis.

CASE 4.—A professional man, unmarried and without relatives, stated that he had been drinking excessively only since the death of his mother, about six months previously. He was an inveterate cigar smoker. His scotoma for white (a 5 mm. test object at 1,000 mm.) was about 8 degrees in the vertical dimension. He refused to cease smoking and drinking (largely wine), and threats of permanently impaired vision brought only replies concerning suicidal intentions. He had ceased making appointments in his office and has since closed it, and he is determined to expend his savings. He was given 100 thiamin chloride tablets and advised to take 12 mg. daily (2 tablets three times a day). In seven and a half weeks his vision was 20/40 and in nine weeks 20/30. He was determined to continue to smoke twelve to fifteen cigars daily and to drink as much wine and more whisky than before he closed his office. His vision in fifteen weeks was 20/20 with a centrocecal scotoma for red and green. He said he had never had polyneuritis.

CASE 5.—The patient received only thiamin chloride, 12 mg. daily. He ceased smoking and drinking promptly, and in seven weeks vision improved from 20/100, and 20/200 to 20/30 in each eye.

This small series of cases suggests the value of thiamin chloride in the treatment of toxic amblyopia. It does not include sufficient studies of the value of nicotinic acid for the treatment of a condition that accompanies a multiple deficiency.

INDUCED SIZE EFFECT

II. AN EXPERIMENTAL STUDY OF THE PHENOMENON WITH RESTRICTED FUSION STIMULI

KENNETH N. OGLE, PH.D.
HANOVER, N. H.

In the first paper of this series [1] the general aspects of a new phenomenon in binocular vision, designated as the induced size effect, was discussed. The nature of this phenomenon will be clear from the following explanation:

When a change in the relative sizes of the images of the two eyes is introduced in the horizontal meridian by placing a meridional size lens before one eye, all objects in a binocular visual field relatively free from strong perspective clues appear as though rotated a certain amount from their original positions about a vertical axis through the fixation point. This apparent rotation of the binocular visual field is to be expected, for obviously it depends on the binocular depth perception that arises from horizontally disparate retinal images. Any change in the relative size in the horizontal meridian will necessarily change the disparities of the retinal images, and, accordingly, new stereoscopic depth values relative to the fixation point must arise for those images. The introduction before one eye of a meridional size lens which magnifies in the horizontal meridian only changes geometrically the disparities of the retinal images, with the result that an apparent rotation occurs for all objects seen binocularly. The direction of this rotation is such that objects on the side of the magnified image will appear farther away; those on the other side will appear nearer. This phenomenon, occurring with a difference in the sizes of the images in the horizontal meridian, is described as a geometric effect, and the magnitude of the apparent rotation as computed from geometric considerations [2] is in agreement with experiment. Thus, the magnitude of the apparent rotation increases almost proportionally to the introduced difference in the sizes of the images.

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1. Ogle, K. N.: Induced Size Effect: I. A New Phenomenon in Binocular Space Perception Associated with the Relative Sizes of the Images of the Two Eyes, Arch. Ophth. **20**:604 (Oct.) 1938.

2. For example, see Ogle, K. N.: Die mathematische Analyse des Längshoropters, Arch. f. d. ges. Physiol. **239**:748, 1938.

Now, contrary to expectations, when a meridional size lens is placed before one eye so as to change the size of the retinal image in the vertical meridian only, objects which are seen binocularly also appear rotated a certain amount from their original positions about a vertical axis. Here, however, the rotation is in the direction opposite to that of the geometric effect; that is, objects on the side of the magnified image appear nearer; those on the other side appear farther away. It is not easy to account for this particular false interpretation of the position of objects in the binocular visual field, since no depth discrimination is known to arise from vertical disparities of the retinal images.[3] So far as the subjective binocular orientation of objects is concerned, the effect is as though the increased size of the image of one eye in the vertical meridian induced an increase in the size of the image of the other eye in the horizontal meridian. Because of the analogy, this phenomenon has been designated the induced size effect.

The two effects differ from each other in one important respect: When the image of one of the eyes is increased in the vertical meridian, the magnitude of the apparent rotation of a test plane increases with the difference in the sizes of the images only within a limited range. Reaching a maximum at these limits, the apparent rotation then actually decreases with a further increase of the difference in the sizes of the images in the vertical meridian. The graphic representation of the induced size effect is a typical elongated S-shaped curve, while that of the geometric effect, when the apparent rotation is virtually proportional to the difference in the sizes of the images in the horizontal meridian, is a straight line in the diagonally opposite quadrants of the graph. These findings definitely point to a physiologic origin of the induced size effect. Certainly, it cannot be explained solely in terms of the properties of the meridional size lenses, as is the case in the geometric effect. Hence, the induced size effect is basically different from the geometric effect.

As described in the previous paper,[1] the data showing these effects were obtained with an apparatus in which the apparent rotation of the binocular field was measured by means of a test plane which the observer could rotate about a vertical axis. The fusion pattern on the plane, as presented to the observer, consisted of a large number of ink dots scattered irregularly over both sides of a sheet of plate glass. Such a complex pattern, while adequate and valuable for demonstrating the

3. For a brief discussion and for references pertaining to the stereoscopic depth localization of vertical disparities, the reader is referred to Tschermak, A.: Optischer Raumsinn, in Bethe, A.; von Bergmann, G.; Embden, G., and Ellinger, A.: Handbuch der normalen und pathologischen Physiologie, Berlin, Julius Springer, 1930, vol. 12, pt. 2, p. 928.

phenomena, is unsuited for a more detailed and fundamental study of the induced size effect. To obtain a finer analysis, simpler and restricted fusion patterns were used on the test plane. The results of the experiments with these patterns are considered in this paper.

EXPERIMENTAL PROCEDURE

The apparatus used and the procedure followed here were essentially those of the preliminary experiments described in the first paper.[1] The difference lay only in the type of the fusion pattern on the test plane presented to the observer.

An observer, whose head is held by a suitable bite or chin cup and adjustable forehead rests, fixates the center of an object plane for a given distance in symmetric convergence (fig. 1). The object plane is free to rotate about a vertical axis through its center. The apparatus is set up so that the visual plane of the observer's eyes will be horizontal. A conveniently placed protractor, calibrated in half degrees, and an indicator permit a measurement of the rotation of the plane from the "frontal" position to an estimated tenth of a degree. The object plane usually consists of a sheet of plate glass 30 by 30 by 0.3 cm., supported in a frame. Suitable figures or contours of different types are drawn in india ink or black paint on the surface of the object plane. A large sheet of white cardboard, uniformly illuminated, suspended for a background, silhouettes the figures seen on the object plane by the observer. A shield of white cardboard mounted at a distance of about 10 cm. before the eyes restricts the field of vision to the object plane. This shield is usually illuminated to the same brightness as the background. The observer can control the rotational orientation of the object plane by means of a cord.

To measure the apparent rotation of the binocular visual field, which is brought about by a meridional size lens before one eye, the observer rotates the test plane until it appears in the same position in which it had been before the difference in the sizes of the images was introduced. This rotation is obviously in the direction opposite to that of the apparent rotation of a fixed plane. In all the experiments to be described here the observer adjusts the object plane so that it appears normal to the direction of its center from him; that is, he adjusts it for an apparent "frontal" position. During a given experiment a number of adjustments of the plane are made for each different combination of meridional size lenses used before the eyes.

In simplifying the fusion pattern, several considerations must be taken into account. The main objective, of course, was to obtain the simplest pattern with which the effect would occur and yet one in which the fusion stimuli would be confined to definite areas on the test plane, hence, to specific regions on the retina. If the test plane is left entirely clear, except for a horizontal row of very small dots, no induced size effect can be found. With an increase of the size of the dots, however, even to the extent of their subtending a visual angle of 0.5 degree, or if the row of small dots is not precisely horizontal, a small induced size effect can be demonstrated. It is clear, therefore, that the effect cannot occur unless the pattern contains vertically separated contours.

The preliminary data were taken with a pattern consisting of a large number of ink dots scattered irregularly on both sides of the entire plane. Such a pattern provides nearly a maximum of vertically separated contours. Decreasing the total number of dots does not essentially change the nature of this pattern. The scattered dots may, however, be grouped in an approximate ring with the center at the fixation point, so that the fusion stimuli are confined to a fairly definite visual angle. But such a pattern has contours extending continuously from the center to the vertical diameter of the ring, and, therefore, it could not be used as a simplified pattern for the basic investigation of the induced size effect. The disadvantages of a ring could be avoided by restricting the scattered dots to two horizontal bands above and below the point of fixation. While such a pattern does confine the fusion contours to fairly specific vertical regions, it introduces an objectionable perspective factor, which may have an influence on the apparent position of the plane.

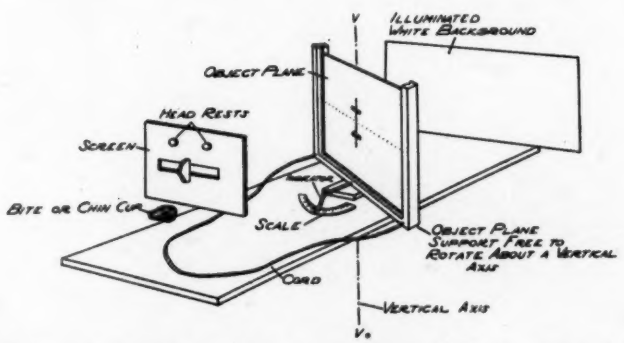

Fig. 1.—Schematic drawing of the apparatus used for a study of the induced size effect.

On the basis of these considerations it was found that the induced size effect would occur even with so simple a fusion pattern as single contours either above or below the center of the plane or both. For the various experiments described here, essentially three different patterns were used (fig. 2). In each case the row of small ink dots was used to provide the necessary horizontal stereoscopic stimuli by which the orientation of the plane about the vertical axis could be ascertained. The dots were 0.5 and 0.75 mm. in diameter and were spaced regularly,[4] about 1 cm. apart, in a horizontal row across the center of the plane. A vertical line (or thread) through the central dots assured fusion. Specifically, the patterns were as follows:

(*a*) At a given vertical distance above and below the horizontal row of dots, small black paper rectangles were fastened on the glass plane,

4. Probably an irregular spacing of these dots would have been better, for any possible empiric factor involved in the regularity would have been avoided.

symmetric with the vertical line.[5] These rectangles provide fusion contours that are simple and can be adjusted for any separation.

(*b*) A small white thread, with narrow ink rings at intervals of approximately 1 cm., fastened horizontally to the frame, was substituted for the row of dots on the sheet of glass. A black thread was again fastened vertically over the axis of rotation of the frame. Above and below the horizontal thread, identical narrow strips of heavy black cardboard were supported by a suitable framework. The inner ends of the strips, placed at equal distances from the horizontal thread, provided the desired fusion contours. The outer ends of the strips and the supports lay outside the field of vision. This pattern restricts the peripheral fusion stimuli in the vertical meridian to two definite contours, which do not rotate with the horizontal row of dots.

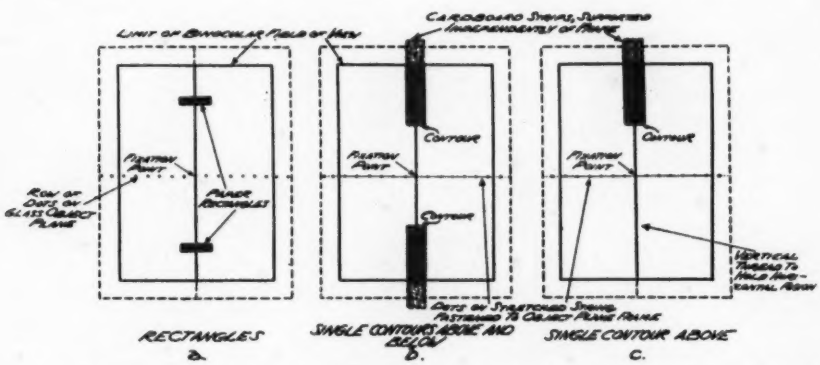

Fig. 2.—Three types of fusion patterns used in a study of the induced size effect.

(*c*) The third pattern is essentially the same as type *b*, though only one of the vertical strips is used. This limits the peripheral fusion stimuli in the vertical meridian to a single contour on one side of the fixation point.

In each of the foregoing patterns the separation of the fusion stimuli, which is necessary if the effect is to occur, is provided by the distance between the horizontal row of dots and the contours.

RESULTS

General Induced Size Effect.—It is possible with the simplified pattern to ascertain the nature of the induced size effect with greater consistency. While the experimental technic and the previous training, and perhaps even the physical condition of the observer, have an effect on the absolute magnitudes of the apparent rotations, the relative behavior

5. Small black hemispheres were substituted in some cases for the rectangles These have the advantage of not changing shape with the rotation of the plane.

of the curves is fundamentally the same for any observer. Inexperienced observers, however, may not always respond at once to so simple a fusion pattern. They may get satisfactory results only after experience has been obtained in taking data with the more complex pattern. Trained observers, on the other hand, are generally only a little less sensitive with the simple than with the more complex pattern.

The data for two observers, illustrated graphically in figures 3 and 4, were obtained by using type *b* pattern, in which the two single contours were at an angular distance of 5 degrees from the center. Table 1 gives the actual data for figure 3. Differences in the sizes of the images in the vertical meridian up to 20 per cent were introduced by accurately ground meridional size lenses [6] placed before either eye. The graphs again show all the general characteristics of the induced size effect. The apparent rotation of the test plane is, within a certain limited range, nearly proportional to the difference in the sizes of the images in vertical meridian. The slope of the line which best fits this portion of the data is defined as the maximum sensitivity of the phenomenon, being stated in degrees of rotation caused by a 1 per cent difference in the sizes of the images in the vertical meridian. Beyond the linear part of the curve, the sensitivity decreases until it becomes zero at the maximum apparent rotation. This point indicates the maximum induced size effect, and a further increase of the difference in the sizes of the images results in a decrease of the apparent rotation. These particular curves are of interest, since they show particularly how the apparent rotation decreases slowly beyond the maxima with larger difference in the sizes of images in the vertical meridian.

Of significance are the relatively small mean deviations of the mean setting of the plane in any given case. A study of table 1 shows that the average mean deviation for the given set of data is about ± 0.8 degrees, with only a few deviations exceeding 1 degree. Since the sensitivity of the apparent rotation of the plane in the geometric effect (difference in the sizes of the images in the horizontal meridian) is roughly 3.5 degrees for 1 per cent for the visual distance of 40 cm., these deviations correspond to relative variations in size of from 0.2 to 0.3 per cent. This agrees with the sensitivity of the eyes to differences in the sizes [7] of the images and again shows strikingly the extreme accuracy to which these depth perception phenomena can be measured.

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6. The meridional lenses used were especially ground so as to have no verging power for the distance of 40 cm. and no magnification in the meridian at right angles to the principal magnification meridian. For theory of design see Ogle, K. N.: The Correction of Aniseikonia with Ophthalmic Lenses, J. Optic. Soc. America **26**:323, 1936.

7. Ames, A., Jr., and Ogle, K. N.: Size and Shape of Ocular Images: III. Visual Sensitivity to Differences in the Relative Size of the Ocular Images of the Two Eyes, Arch. Ophth. **7**:904 (June) 1932.

From an extensive study of the problem it has been ascertained by trial and error that a set of data for induced size effect can be satisfactorily described algebraically (with respect to the center of symmetry) by $y = ax/(b + x^2)$, in which y is the rotation of the plane caused by a difference in the sizes of the images of x (positive for an increase in the image in the right eye) and a and b are constants. The ratio a/b specifies the maximum sensitivity. If $\bar{x}$ is the difference in the sizes of the images, expressed in percentage, for the maximum rotation $\bar{y}$, $b = \bar{x}^2$, from whence it follows that $a = 2\bar{x}\bar{y}$. For small values, the rotation

TABLE 1.—*Typical Data of the Induced Size Effect* *

Lenses Before Right Eye, Axis Horizontal		Lenses Before Left Eye, Axis Horizontal	
Difference in Sizes of Images in Vertical Meridian, Percentage L < R	Rotation of Plane, Degrees	Difference in Sizes of Images in Vertical Meridian, Percentage R < L	Rotation of Plane, Degrees
Normal	—3.7 (0.4)		
1.0	—1.5 (0.7)	1.0	— 6.0 (0.7)
2.0	+0.5 (0.7)	2.0	— 8.2 (0.2)
4.0	+2.4 (0.7)	4.0	—12.1 (0.8)
6.0	+0.8 (0.8)	6.0	—13.1 (0.8)
8.0	+0.5 (1.2)	8.0	—11.9 (0.8)
10.0	—0.7 (1.0)	10.0	—12.6 (0.7)
12.0	—0.5 (0.5)	12.0	—12.6 (0.5)
14.6	—2.1 (0.7)	14.6	—11.9 (0.4)
16.7	—2.2 (0.9)	16.7	—10.9 (0.9)
19.0	—3.7 (1.1)	19.0	—10.1 (0.6)
21.3	—3.0 (0.8)	21.3	—10.5 (1.0)

* The data for this observer (K. N. O.) were obtained with an object plane pattern consisting of two separate contours.

The data are the degrees of rotation of the plane from the true frontal position (with mean deviations) about a vertical axis (counterclockwise rotations are taken positive) when the plane is adjusted for an apparent "frontal" position for a given difference in the sizes of the images in the vertical meridian introduced by meridional size lenses. The visual distance equaled 40 cm.

These data are the mean of two individual sets of data. The mean deviations given are the average of the mean deviations of each set.

The slope of the straight line portion of the data, that is, the maximum sensitivity equaled 2.7 degrees for a 1 per cent difference.

The average difference in the sizes of the images in the vertical meridian for maximum rotation equaled 5.5 per cent.

The average maximum rotation of the test plane was 7.5 degrees.

The center of symmetry of data equaled —6.3 degrees and —1.2 per cent.

of the plane is directly proportional to the difference in the sizes of the images, while for larger values the denominator of the fraction becomes more and more dominant and the rotation decreases asymptomatically with a horizontal axis. The curves drawn to represent the data in figures 3 and 4 (and subsequent data) have been computed from this equation, suitable values for the constants a and b being used. It must be borne in mind that this relation is used only as a device to provide uniformity in the representative curves, and it might not be applicable to data obtained with differences in the sizes of the images greater than those used in these experiments. Moreover, the equation is used here without regard to any theoretic implications.

A study of the data in figures 3 and 4 is of special interest from the point of view of vertical disparity of the retinal images instead of from the point of view of differences in the sizes of the images in the vertical meridian.

Since in these experiments the contours for stimuli to fusion in the vertical meridian are confined to a specific visual angle, the result of increasing the size of the image in one eye in the vertical meridian is to

Fig. 3.—A graphic illustration of a typical set of data (for K. N. O.) showing the induced size effect for large differences in the sizes of images when the fusion in the vertical meridian is restricted to two separate contours. The visual distance equaled 40 cm.

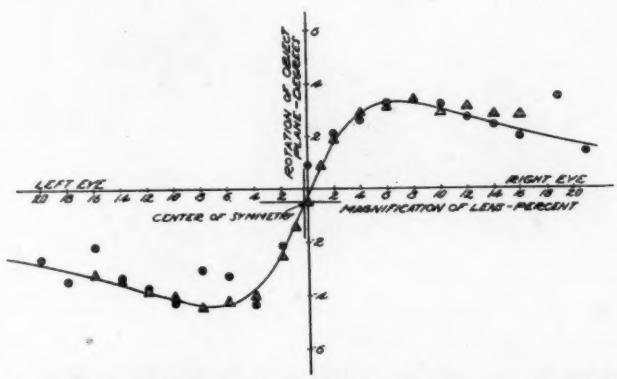

Fig. 4.—A graphic illustration of a typical set of data (for G. S. N.) showing the induced size effect for large differences in the sizes of the images when the fusion in the vertical meridian is restricted to two separated contours. The visual distance equaled 40 cm.

introduce a vertical disparity between the retinal images of the contours. This situation is illustrated schematically in figure 5, in which the eyes are shown fixating the horizontal row of dots, while the contour above (and likewise the one below) provides a peripheral stimulus to fusion in the vertical meridian. Without a size lens before the left eye, the retinal images of these contours would under normal conditions fall on ver-

tically corresponding retinal elements. The introduction of the size lens before the left eye, however, displaces the retinal image of the contour in that eye downward, so that the contour to that eye appears higher than the corresponding contour in the right eye. This difference in position of the retinal images of the same contour constitutes a vertical disparity of the retinal images, which is usually expressed by a small visual angle (δ in fig. 5). The magnitude of the disparity will be directly proportional to the magnification of the size lens and to the distance of the contour from the horizontal row of dots.

For small changes in the sizes of the images, the apparent rotation of the test plane is nearly proportional to the disparity of the retinal images. As the magnitude of the disparity increases, the increase in the apparent rotation becomes smaller, until it finally stops. Obviously, the observer is still responding to an increasing disparity of the retinal

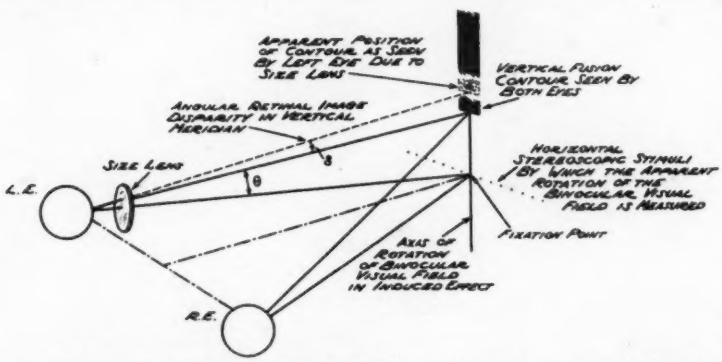
Apparent Position of Contour as Seen by Left Eye Due to Size Lens
Vertical Fusion Contour Seen by Both Eyes
Angular Retinal Image Disparity in Vertical Meridian
Size Lens
L.E.
θ
δ
Horizontal Stereoscopic Stimuli by Which the Apparent Rotation of the Binocular Visual Field is Measured
Fixation Point
Axis of Rotation of Binocular Visual Field in Induced Effect
R.E.

Fig. 5.—Schematic diagram showing the equivalent angular disparity of the retinal images caused by the difference in the sizes of the images introduced by a size lens.

images, beyond the point of maximum apparent rotation, though that response is decreasing slowly.

It would be of importance to know the disparity at which the response ceases entirely. Since this is difficult to ascertain experimentally, only inferences can be drawn from the data at hand. On the assumption that the analytic expression represents the data, extrapolation would indicate that although the response decreases, it never ends entirely. If an extrapolation is made for the difference in the sizes of the images at which the magnitude of the induced size effect is of the order of the precision of measurements of the experiments, the disparity is about twice the distance of the contours from the row of dots. While this estimate is probably much too high, even the magnitude of the disparity indicated at the ends of the experimental curves transcends any known retinal physiologic unit or area, in the sense of a fusion area. Such magnitudes would tend to imply, therefore, that the induced effect is the result of certain cortical processes.

One might suspect that the behavior of the induced curve beyond the maximum rotations is a fatigue phenomenon. However, the data of several experiments showed the same characteristic curve, regardless of the order in which the data were taken or the length of time employed for each setting.

A similarity can be found between the decrease of the induced size effect with large differences in the sizes of the images in the vertical meridian (or disparities of the retinal images) and the results of certain experiments with fusional movements.[8] As is known, vertical fusional movements, in the sense of a vertical divergence, can be caused by a vertical displacement of the stimulating images. Up to a certain point these movements are proportional to the initial displacement of the images. Beyond this point the resulting ocular movements lag farther and farther behind the displacement of the stimulating images, indicating that the fusion stimulus exerted by the images decreases with the amount of this displacement. In the induced size effect, a similar weakening of the fusion strength for large disparities of the retinal images can be assumed. Such a weakening might account for the S-shaped curve so characteristic of the induced effect, if that effect results from a fusion effort. Within certain limits the fusion impulse is strong enough to cause a full effect, while beyond these limits the weakening of the fusion stimuli result in a steady decrease of the effect. Under given experimental conditions, then, the influence of the vertical disparity of the retinal images introduced by the size lenses would never cease entirely, though the magnitude of the apparent rotation of the binocular visual field is eventually below the precision of measurement.

Influence of Changing the Vertical Separations of the Fusion Contours.—The results described show that the induced size effect occurs with a simple fusion pattern consisting of as little as a single contour separated from the horizontal row of dots; thus, one must infer that the effect is a response to a simple disparity of retinal images confined to relatively small areas on the two retinas. The question then arises: How does the effect vary for different distances of the contours from the fixation point? That is, how does the effect vary as a response to disparities of the retinal images at different excentric parts of the retinas?

For this study, the separated rectangles (*a*) and the single contour (*c*) types of patterns were used at a visual distance of 40 cm. In the first case a series of test planes were prepared in which the rectangles were spaced so as to subtend visual angles of 1 degree and 2.1, 3.5, 5, 7.2, 9.2 and 11.4 degrees both above and below the horizontal row of

8. Burian, H.: Fusional Movements: Role of Peripheral Retinal Stimuli, Arch. Ophth. **21**:486 (March) 1939.

dots. With rectangles 2 cm. by 0.2 cm., spaced 3.5 cm. from the horizontal row of dots for a visual angle of 5 degrees (visual distance equals 40 cm.), as the standard, the size of the small rectangles for the other planes was increased in proportion to the visual angle. In the second case the series of suspended strips of black paper provided single fusion contours for visual angles of 1 degree and 2, 3.5, 7, 9 and 12 degrees from the horizontal row of dots. The width of the strips in every case was 8 mm.

Data for S type curves for each of these patterns were obtained by three observers.[9] Differences in the sizes of the images in the vertical meridian up to 10 and 12 per cent were used. The data illustrating the results of the two patterns for two observers are shown in figures 6 and 7. The symmetric curve in each figure best fits the experimental points as a whole and is consistent with the analytic expression given previously. From each of the curves the following significant characteristics are ascertained, either by inspection or by determination from the constants of the analytic curves:[10] (1) the maximum sensitivity, given by the slope of the line which best fits the central portion of the curve; (2) the difference in the sizes of the images in the vertical meridian for which the maximum rotation[11] has occurred; (3) the maximum rotation[11] of the object plane; (4) the center of symmetry of the curve, specified by a percentage of difference in the sizes of the images, and a rotational position of the object plane.

The derived values for all the observers are given in table 2.

Maximum Sensitivity: The values for the maximum sensitivity (degrees of rotation for a 1 per cent difference in the sizes of the images in the vertical meridian at the center of symmetry) for the various patterns subtending different visual angles to the fusion contours are given for the various observers in the first row of the table. They

9. The ocular characteristics of the three observers follow: for K. N. O., vision of 20/15 in the right eye and 20/15 in the left eye (binocularly accepted a + 0.25 D.), with 3 degrees of esophoria for near vision; for R. H. D., vision of 20/15 in the right eye with a + 0.25 sph. ⊃ + 0.25 cyl., axis 90 and 20/15 in the left eye with a + 0.50 sph.; also 2.25 degrees of exophoria for near vision; for G. S. N., vision of 20/15 in the right eye with a + 0.75 sph. and 20/15 in the left eye with a + 0.87 sph.; also orthophoria (± 0.5 degrees) for near vision. The data for all observers were taken without refractive correction.

10. It is believed that a more consistent series of derived values for these characteristics can be obtained by the method used here, viz., that of finding the constants of the analytic curve which fits each set of data as a whole rather than any other method of inspection.

11. Because of the fact that the center of symmetry of the induced size effect curve for many observers is displaced from the origin of the graph, the expressions "difference in the sizes of the images for the maximum rotation of the test plane" and "the maximum apparent rotation of the test plane" will refer to the average values or to those measured from the center of symmetry.

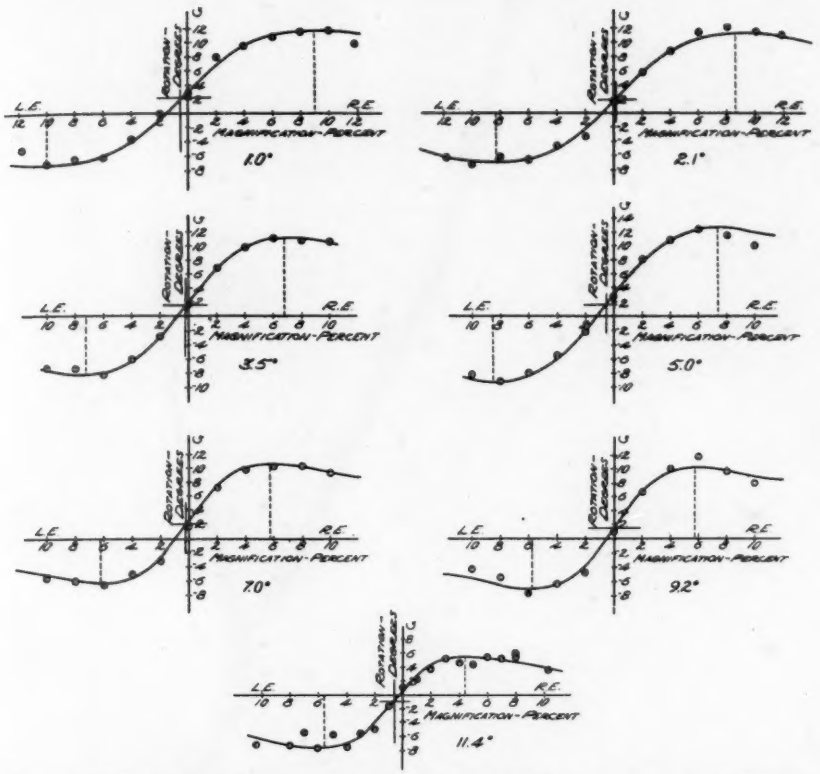

Fig. 6.—Graphic illustration of data (for R. H. D.) showing the induced size effect for different vertical angular distances of the fusion contours from the fixation point. The data are the apparent rotation (degrees) of the object plane caused by differences in the sizes of the images in the vertical meridian (percentage) introduced by meridional size lenses. The visual distance equaled 40 cm., and the pattern consisted of two rectangles.

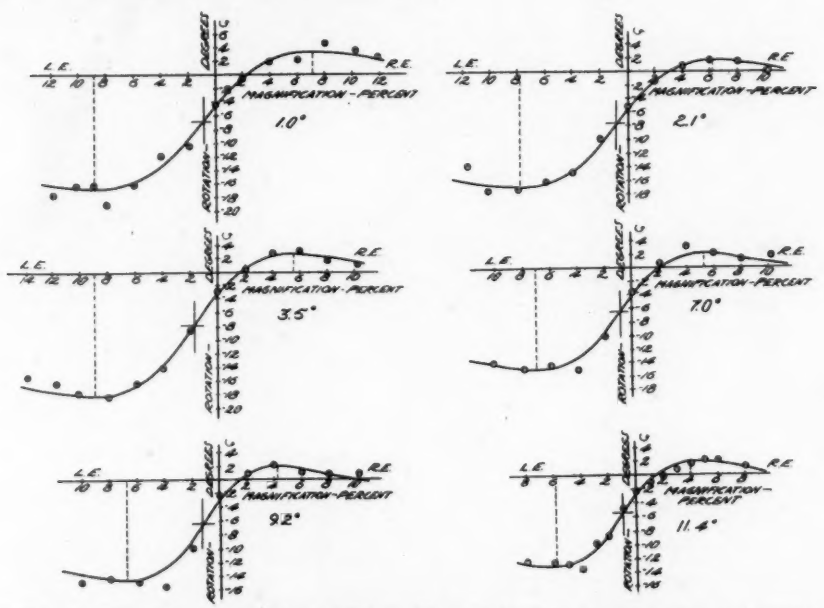

Fig. 7.—Graphic illustration of data (for K. N. O.) showing the induced size effect for different vertical angular distances of the fusion contours from the fixation point. The data are the apparent rotations (degrees) of the object plane caused by differences in the sizes of the images in the vertical meridian (percentage) introduced by the meridional size lenses. The visual distance was 40 cm., and the pattern consisted of two rectangles.

are illustrated graphically in figure 8. Inspection shows that the maximum sensitivity for all the visual angles within a relatively small variation is the same for the same observer and for the same pattern. In several cases perhaps a small, though not particularly significant, increase occurs.

TABLE 2.—*Summary of the Characteristic Data of Three Observers Derived from the Induced Size Effect S-Type Curves for Two Simple Types of Object Plane Patterns*

Test Pattern—Rectangles (Observer K. N. O.)							
Visual angle subtending contours.....	1°	2.1°	3.5°	5°	7.2°	9.2°	11.4°
Maximum sensitivity, degrees/per cent..	2.5	2.6	2.9	...	2.8	3.0	3.0
Difference in sizes of images for maximum rotation, percentage.....	8.0	7.0	7.2	...	6.2	5.5	5.0
Average maximum rotation, degrees....	10.0	9.4	10.5	...	8.5	8.2	7.5
Center of symmetry							
Percentage	−0.9	−0.9	−1.7	...	−0.8	−1.2	−1.0
Degrees	−6.8	−7.6	−7.8	...	−6.4	−6.3	−5.4
Test Pattern—Single Contour Above (Observer K. N. O.)							
Visual angle subtending contours.....	1°	2.1°	3.5°	5°	7°	9°	12°
Maximum sensitivity, degree/per cent..	2.2	1.9	...	2.0	1.9	1.9	1.8
Difference in sizes of images for maximum rotation, percentage.....	5.0	5.5	...	5.0	4.6	4.2	3.7
Average maximum rotation, degrees....	5.5	5.2	...	5.1	4.4	4.0	3.3
Center of symmetry							
Percentage	−1.1	−1.0	...	−1.0	−1.2	−1.3	−1.1
Degrees	−6.3	−6.3	...	−7.0	−7.2	−7.7	−6.8
Test Pattern—Rectangles (Observer G. S. N.)							
Visual angle subtending contours.....	1°	2.1°	3.5°	5°	7.2°	9.2°	11.4°
Maximum sensitivity, degrees/per cent..	1.3	1.3	1.4	1.6	1.8	1.9	1.8
Difference in sizes of images for maximum rotation, percentage.....	8.3	8.1	7.5	7.0	6.1	5.5	6.1
Average maximum rotation, degrees....	5.0	6.0	6.6	6.6	6.3	5.3	5.6
Center of symmetry							
Percentage	−1.0	−1.0	−0.7	−1.0	−0.5	0.0	−0.6
Degrees	−1.6	−1.9	−0.9	−2.2	−2.0	−0.9	−1.6
Test Pattern—Single Contour Above (Observer G. S. N.)							
Visual angle subtending contours.....	1°	2°	3.5°	5°	7°	9°	12°
Maximum sensitivity, degrees/per cent..	0.8	1.0	1.3	1.0	1.4	1.0	0.8
Difference in sizes of images for maximum rotation, percentage.....	6.5	5.8	5.7	6.0	4.7	5.5	4.0
Average maximum rotation, degrees....	2.7	2.8	3.7	3.0	3.2	2.8	1.5
Center of symmetry							
Percentage	+0.1	−0.4	−0.6	−0.8	−0.7	−1.3	−0.2
Degrees	−2.2	−3.2	−3.4	−4.3	−3.2	−3.3	−2.5
Test Pattern—Rectangles (Observer R. H. D.)							
Visual angle subtending contours.....	1°	2.1°	3.5°	5°	7°	9.2°	11.4°
Maximum sensitivity, degree/per cent..	1.9	2.1	2.7	2.6	2.8	2.9	2.6
Difference in sizes of images for maximum rotation, percentage.....	9.5	8.5	7.0	8.0	6.0	5.7	5.0
Average maximum rotation, degrees....	9.3	9.0	9.7	10.5	8.4	8.3	6.6
Center of symmetry							
Percentage	−0.5	+0.1	−0.2	−0.5	0.0	0.0	−0.5
Degrees	+2.2	+1.8	+1.5	+1.6	+0.8	+0.3	−1.0

This result does not imply that the sensitivity of the retina—that is, the response of the retina per unit of area—is uniform from the fovea to the periphery. The displacement of the image of an object on the retina caused by a size lens will be proportional to the angular distance

of that point from the fixation point.[12] Therefore, the fact that the maximum sensitivity of the induced size effect, as previously defined, is apparently independent of the angular separation of the fusion contours implies that the sensitivity of the retina may decrease with the distance from the fovea to a point on the periphery. The proportional increase of the disparity of the images with the increased size of the image at least partly offsets the reduction in sensitivity. In other words, for a 1 per cent increase in the vertical meridian of the image of one eye, the resulting vertical disparity of 0.01 degree at 1 degree from the fovea and a disparity of 0.1 degree at 10 degrees from the fovea will elicit the same ocular response in an induced size effect. The decrease in retinal sensitivity expressed in the constancy of the maximum sensitivity doubtless has the same functional or structural basis as has the decrease in resolving power of the retina and the decrease in the fusion strength from the fovea to the periphery.

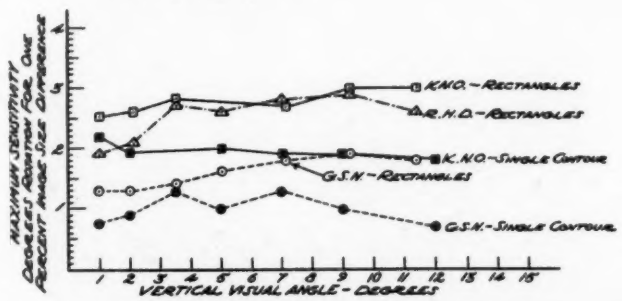

Fig. 8.—Graphic representation of the relationship derived between the maximum sensitivity to the induced size effect and the vertical visual angle subtending the fusion contours.

According to the data, however, the maximum sensitivity varies with the observer and with the pattern. Individual differences are to be expected, though the values are rather constant for the same observer. A summary of the maximum sensitivities of the different patterns for the three observers is given in table 3. This table clearly indicates that the maximum sensitivity, which reaches nearly the theoretic maximum for the full field of dots,[1] is far larger for the more complex patterns than it is for the simpler ones. This must be interpreted to mean that the retinal sensitivity is considerably higher for the more complex patterns. Accordingly, the maximum sensitivity of the effect is also larger with the more complex patterns.

12. A 10 per cent size lens, for example, placed before one eye will cause an image displacement of 0.1 degree at 1 degree from the fovea and an image displacement of 1 degree at 10 degrees from the fovea.

Difference in the Sizes of the Images in the Vertical Meridian and the Maximum Apparent Rotation at the Point of Maximum Effect: One of the most important values obtained from a given curve of induced size effect is the difference in the sizes of the images in the vertical meridian for which the maximum apparent rotation occurs. These derived values are given for each observer in the second rows of table 2 and are represented graphically in figure 9. With an increase in the separation of the contours, the curves show clearly a decrease in the values for the difference in the sizes of the images in the vertical meridian at which the maximum effect occurs; that is, the farther the fusion contours are from the fixation point, the smaller is the difference in the sizes of the images at which the maximum rotation of the test plane takes place. The relationship appears nearly linear.

TABLE 3.—*Summary of Maximum Sensitivities for Different Patterns on Object Plane* *

Pattern	Observer		
	K. N. O.	R. H. D.	G. S. N.
Full field of dots	3.0	3.9	3.3
Ring of dots (5°)	3.3	3.5	2.2
Bands of dots (5°)	...	3.8	...
Black hemispheres (5°)	...	...	1.9
Average rectangles (1°-12°)	2.8	2.5	1.6
Average single contour (1°-12°)	2.0	...	1.0
Theoretic maximum †	3.6	3.9	3.8

* The values are degrees of apparent rotation for a 1 per cent difference in the sizes of the images in the vertical meridian.

† It is assumed that the value for the theoretic maximum will be equal to the theoretic sensitivity for the geometric effect, though opposite in sign.[1]

Since the maximum sensitivity is nearly constant for all visual angles subtended by the fusion contours and the difference in the sizes of the images in the vertical meridian for the maximum rotation decreases with the increase of the visual angle, it is to be expected that the magnitude of the maximum rotation also decreases with the increasing visual angles to the fusion contours. This is actually the case, as can be seen from table 2, third row, and from figure 10, in which the values of the maximum apparent rotation of the object plane are given and illustrated.

The change in the difference in sizes of the images in the vertical meridian for which the maximum effect is found and the change in the magnitude of the maximum rotation itself, both of which occur with an increase in the visual angle subtending the contours, may also be considered from the point of view of a fusion phenomenon. As suggested previously, the stimuli for fusion from a peripherally located contour becomes weaker as its distance from the fixation point is increased. Consequently, with an increase in the distance, a decrease would be

expected not only in the maximum difference in the sizes of the images in the vertical meridian but also in the magnitude of the maximum effect itself.

The differences observed between the different patterns with respect to the difference in the size of the images for the maximum effect and the maximum apparent rotation itself may be accounted for on the assumption that the induced size effect becomes smaller as the fusion

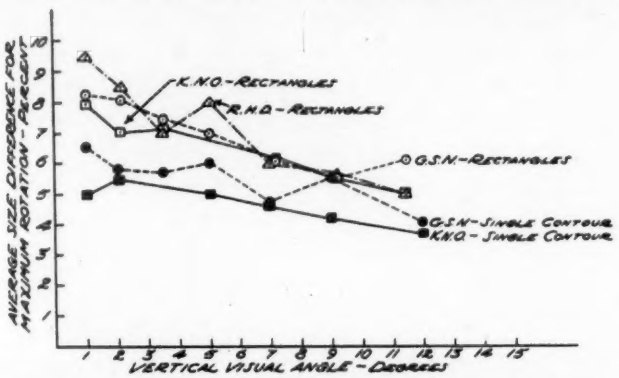
AVERAGE SIZE DIFFERENCE FOR MAXIMUM ROTATION - PERCENT
K.N.O - RECTANGLES
R.N.O - RECTANGLES
G.S.N - RECTANGLES
G.S.N - SINGLE CONTOUR
K.N.O - SINGLE CONTOUR
VERTICAL VISUAL ANGLE - DEGREES

Fig. 9.—Graphic illustration of the relationship derived between the average difference in the sizes of the images in the vertical meridian for the maximum induced effect and the vertical visual angle subtended by the fusion contours.

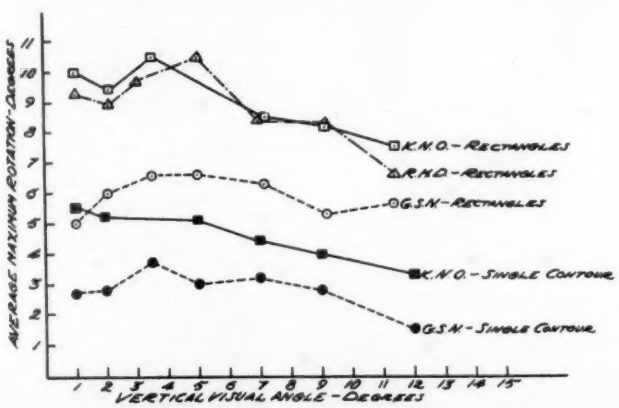

Fig. 10.—Graphic representation of the derived data showing the relationship between the average maximum rotation of the object plane in the induced size effect and the vertical visual angle subtended by the fusion contours.

stimuli become weaker. From the graphs in figures 9 and 10 it will be seen that the values for the rectangular patterns are considerably higher than those for the single contours. In considering these differences, two points must be taken into account: first, that the rectangular patterns are increased in size in proportion to their distance from the center; and, second, that the single contours were placed only above the horizontal row of dots, whereas the rectangles were placed both above and

below the dots. Thus, the fusion stimuli of the rectangles must have been more than twice as strong as that of the single contours. The weakening influence of the increasing distance of the fusion contours from the fixation point in the case of these rectangles is compensated for in part by the stimulation of a larger retinal area, both above and below the fixation point.

The values for the differences in the sizes of the images in the vertical meridian for which the maximum effect occurred may also be interpreted in terms of a limiting disparity of the retinal images. These equivalent disparities, which can easily be computed from the derived data,[13] are shown in table 4 for the various vertical visual angles subtended by the fusion contours. Figure 11 illustrates these values. It will be seen that the limiting disparity increases with increasing visual

TABLE 4.—*Equivalent Disparities of the Retinal Images for Average Difference in the Sizes of the Images in the Vertical Meridian at Which the Maximum Apparent Rotation of the Object Plane Occurred for the Various Vertical Visual Angles Subtending the Fusion Contours*

	Minutes of Arc						
Vertical Visual Angles of Fusable Contours, Degrees	Rectangles			Single Contour		Average Rectangles	Average Single Contour
	K. N. O.	R. H. D.	G. S. N.	K. N. O.	G. S. N.		
1.0	4.8	5.7	5.0	3.0	3.9	5.2	3.4
2.0	....	....	....	6.6	7.0	9.9	6.8
2.1	8.8	10.7	10.2	....	....	....	....
3.5	15.1	14.7	15.8	....	12.0	15.2	12.0
5.0	....	24.0	21.0	15.0	18.0	22.5	16.5
7.0	....	25.2	....	19.3	19.7	26.1	19.5
7.2	26.8	....	26.4	....	....	....	....
9.0	....	....	....	22.7	29.7	30.8	26.2
9.2	30.4	31.5	30.4	....	....	....	....
11.4	34.2	34.2	41.7	....	....	....	....
12.0	....	....	....	26.6	28.8	36.8	27.7

angles; this is to be expected if the retinal sensitivity to the effect decreases from the foveas to the peripheral parts of the retinas.

The data given in table 4 and illustrated in figure 11 show, however, that the limiting disparities for the maximum induced size effect are larger for the rectangular pattern than are those for the simpler single contour. This behavior is not inconsistent with the concept that the sensitivity of the retina to the effect decreases toward the periphery and that the retinal sensitivity increases with the strength of the stimulus to fusion.[14]

13. For example, the maximum effect for a visual angle of 1 degree is reached with a difference in the sizes of the images of 7 per cent (fig. 7, graph 1); hence, the vertical disparity of the retinal images is equal to 7 per cent of 1 degree, or 0.07 degree, or 4.2 minutes of arc.

14. A similar behavior of complex as against simple patterns is found in certain vertical fusion experiments involving fusion movements (Hofmann, F. B., and Bielschowsky, A.: Ueber die der Willkür entzogenen Fusionsbewegungen der Augen, Arch. f. d. ges. Physiol. **80**:6, 1900).

The limiting retinal disparities for the maximum induced size effect are of interest also from another point of view, in that they may be considered analogous to "Panum's areas of sensation," within which disparate images can be fused. The limiting disparities in the induced effect may be said to define certain "areas of induction," within which the effect increases with the vertical disparity and outside of which the effect decreases. In general, these "areas of induction" appear slightly larger than Panum's areas of binocular single vision. It was the impression of the various observers that the simple contours on the object plane appeared to "double" vertically at a difference in the sizes of the images on the vertical meridian slightly smaller than that at which the maximum apparent rotation occurred. No data exist for the vertical dimensions of Panum's areas in the peripheral parts of the retinas, with which a quantitative comparison can be made. However, since it is generally

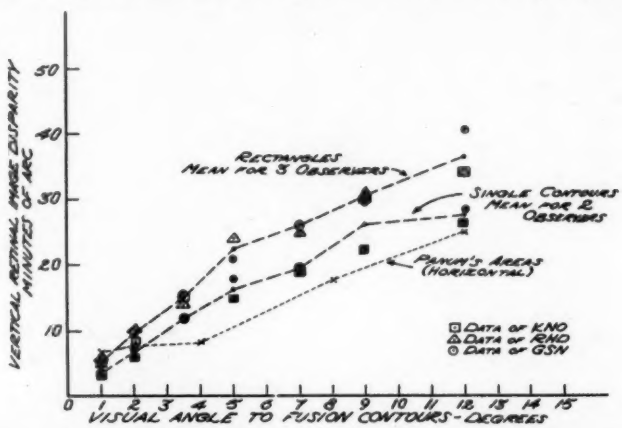

Fig. 11.—Graphic representation of the disparities of the retinal images which are derived from the data for the differences in the sizes of the images at which the maximum apparent rotation of the test plane for the different visual angles subtended by the fusion contours.

believed that their vertical dimensions are smaller than their horizontal ones, it is of interest to include in figure 11 the values for the horizontal dimensions of Panum's areas, as determined on the horopter apparatus.[15] These values permit no actual comparison but do provide a general idea as to the relative sizes of the induction areas for the two patterns and the areas of single vision.

Center of Symmetry: A comprehensive consideration of the problem raised by the fact that for some observers the center of symmetry of

15. Ogle, K. N.: An Analytical Treatment of the Longitudinal Horopter: Its Measurement and Application to Related Phenomena, Especially to the Relative Size and Shape of Ocular Images, J. Optic. Soc. America **22**:665, 1932.

the induced size effect S type curve is displaced from the origin of the graphs is beyond the scope of this paper and can only be touched on. In connection with the experiments discussed here, it is important only to determine what changes occur in the displacement with the different separations of the fusion contours. The coordinates for the centers of symmetry for the foregoing series of data are given in table 2. Since the data were taken over a considerable period of time, some variation in these values might be expected. The tables, however, show no such consistent trend with increasing separations of the fusion contours within mean variations of 0.5 per cent and 1 degree. A marked trend in the displacement of the center of symmetry for the series of vertical visual angles might indicate some asymmetry of the retinal images. The displacement of the center of symmetry itself suggests an initial inequality in the relative sizes of the ocular images of the two eyes.

COMMENT

Certain fundamental facts, based on the data of three observers, have been brought out in the experiments described in the foregoing pages.

The induced size effect does not occur unless there are present in the binocular visual field at least two vertically separated contours which will exert a vertical fusion innervation. The magnitude of the effect apparently depends on the number and the orientation of the contours seen binocularly in the field of view.

With the number of contours restricted (though for some observers, even this restriction is unnecessary), the effect reaches a definite maximum for specific differences in the sizes of the images in the vertical meridian. When these differences increase still further, the effect decreases slowly. This fact indicates that the induced size effect rests on a physiologic basis.

In considering the various aspects of the foregoing data, it appears that the induced size effect may be the response to the effort of fusing two vertically unequal disparate retinal images. The strength of the response will depend then on the intensity of the stimuli for that fusion innervation. It appears also that the sensitivity to such stimuli decreases toward the peripheral parts of the retinas.

With sufficient vertical fusion stimuli in the binocular visual field, an increase in the disparities of the retinal images, introduced by size lenses, results in an increase of the induced size effect up to a certain maximum, beyond which a further increase of the disparities results in a gradual decrease of the effect. On the basis of the foregoing hypothesis, the strength exerted by the fusion stimuli from supramaximal disparities decreases, and a smaller induced effect results.

Similarly, this hypothesis explains the fact that the difference in the sizes of the images in the vertical meridian for the maximum induced size effect and the magnitude of this effect itself vary with different patterns and with the angular vertical distance of the contours from the fixation point. In general, a greater effect is obtained with patterns which present a greater fusion stimulus. Within certain limits, the greater the number of contours and the closer these are to the fixation point, the greater becomes the difference in the sizes of the images for the maximum effect and the magnitude of the effect itself.

Certain aspects in this consideration deserve special attention. For example, the fact that the maximum sensitivity, defined as the magnitude of rotation of the field for a 1 per cent difference in the size of the images in the vertical meridian in the vicinity of the center of symmetry, remains nearly constant for different separations of the vertical fusion contours. The constancy of the maximum sensitivity of the effect may be understood in terms of retinal sensitivity, if the sensitivity for the fusion of disparate images is assumed to decrease from the fovea to the periphery.[16] In these experiments such a decrease of sensitivity tends to be compensated for by the increase of the disparity of the retinal images toward the periphery caused by the size lenses. However, on this assumption, the vertical disparity of the images for which the maximum induced size effect occurs, as well as the magnitude of the maximum effect itself, must also decrease with increasing separations of the vertical fusion contours.

It is of special interest, also, to interpret the difference in the sizes of the images in the vertical meridian for the maximum induced size effect as a limiting disparity of the retinal image. On the basis of the data, it follows, first, that these limiting disparities increase toward the periphery of the retinas; and, second, that they are larger for the more complex patterns. The first fact might be expected, on the basis of the hypothesis that the retinal sensitivity gradually decreases toward the periphery of the retinas. The second fact might also be expected in that a greater response probably would occur to the stronger stimuli that arise from the more complex contour pattern. Thus, a larger disparity of the images, i. e., a greater retinal area, must be involved before the maximum effect will occur for increasing separations of the vertical contours. These limiting vertical disparities may be considered as retinal areas, in the sense of Panum's areas of binocular single vision. The existence of such "areas of induction" can be postulated, but on the basis of the foregoing data they appear unstable, since their magnitudes vary with the nature of the test pattern.

16. Such an assumption is justified on other grounds, especially in view of the results of certain fusion movement experiments (Burian[8]).

As suggested in the preceding paper,[1] the induced size effect itself can be explained on the hypothesis that a compensatory change takes place in the relative sizes of the ocular images. So far as binocular depth perception is concerned, this theory assumes that the ocular processes can compensate for the difference in the sizes of the images in the vertical meridian which has been artificially introduced by size lenses; but such a compensation can be made only as an overall change in size, or as a meridional increase in the one meridian accompanied by a decrease of the image in the other meridian.[17] Such an image compensation obviously leaves a residual horizontal difference in the relative sizes of the ocular images, and the apparent rotation of the binocular field would occur, as in the geometric effect, from this horizontal difference. On the whole, such a hypothesis is consistent with the foregoing data and their interpretation, for the compensatory process would be the response to the fusion stimuli exerted by vertically disparate images. The fact that the maximum sensitivity of the effect for a given pattern is the same for all separations of the vertical contours is easily accounted for. Within relatively small differences in the sizes of the images in the vertical diameter, the compensatory mechanism responds to the same extent in compensating for the vertical disparity, irrespective of where the images lie. An increase in the number of contours would increase the strength of the innervation to the compensatory mechanism. Moreover, a maximum effect will simply indicate a limitation of the compensation processes. Beyond the maxima, there would be a continuous attempt to compensate for the vertical disparity, though the influence of the fusion patterns becomes weaker with the larger disparities. To explain the fact that the differences in the sizes of the images for the maximum effect vary with the angular distance of the contours in peripheral vision, it must be assumed that the limits of the compensating process vary with the retinal distances from the foveas.

The conception of a compensatory process, of course, is only a way of describing the phenomena observed. No physiologic or anatomic basis for such a process is known at present.

SUMMARY

With simplified fusion patterns it is possible to ascertain the following facts concerning the induced size effect:

1. The introduction of a difference in the sizes of the images in the vertical meridian does not cause an induced size effect unless there are at least two separated vertical contours in the binocular visual field.

17. This is true in the sense that a ribbon of rubber when stretched contracts in the direction at right angles to the direction of the stretching.

2. This difference in the sizes of the images for the maximum induced size effect decreases with increasing separations of the fusion contours.

3. The magnitude of the maximum induced size effect decreases with increasing angular distances of the fusion contours from the fixation point.

4. The maximum sensitivity (the apparent rotation of the binocular visual field for a 1 per cent difference in the sizes of the images at the center of symmetry) varies with the observers and with the patterns but is nearly constant for different visual angles subtended by the fusion contours.

The experimental findings are discussed from the point of view of the strength of fusion stimuli for disparity of the retinal images and of a hypothetic effective change in the sizes of the ocular images.

CONGENITAL TYPE OF ENDOTHELIAL DYSTROPHY

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Endothelial dystrophy, or cornea guttata, is generally considered at the present time to be a degenerative senile or presenile condition which may progress and later predispose to epithelial changes, notably the epithelial dystrophy of Fuchs. This concept, which is the only one held by all English and American contributors to the subject, is based on the work of Vogt and of Graves. Even the recent textbook by Duke-Elder [1] shares this point of view and, like other texts, in an apparently complete discussion omits any reference to the original describers, first Koeppe and later Staehli, and fails to mention several case reports which point to a congenital basis for some of these cases. Because of this misconception, the condition in the cases reported here was at first unclassified and, in fact, considered hitherto undescribed. It was only after a fairly complete review of the literature that its nature was understood and that it was realized that there might be several types of endothelial dystrophy.

REPORT OF CASES

CASE 1.—Sylvia L., a girl of 18, was observed at birth to have "cloudy, gray" corneas. At the age of 3 months, on Nov. 28, 1919, she was taken to the clinic of the Herman Knapp Memorial Eye Hospital, where bilateral deep corneal opacities were noted, but the age of the patient precluded more detailed study. Subsequently, at several clinics in the city of New York, she was given glasses because of poor vision, but these never brought about any significant improvement. On April 12, 1938, she returned to the Herman Knapp Memorial Eye Hospital after an absence of eighteen years, hoping to improve her vision with new glasses.

Ocular Examination.—The vision in the right eye was 20/70 — 2; it improved to 20/70 + 1 with a + 0.75 sph. — 1.25 cyl., axis 105. The vision in the left eye was 20/80; it improved to 20/60 — 1 with a — 0.50 sph. — 2.50 cyl., axis 55.

The entire ocular examination gave negative results except for the cornea of each eye and the anterior capsule of the lens in the left eye. The media and the fundi showed no abnormalities or evidences of old inflammation.

The cornea of each eye was normal in size and shape. There was no impairment of sensation. Grossly, each appeared somewhat cloudy. On slit lamp examina-

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From the Herman Knapp Memorial Eye Hospital, clinic of Dr. J. M. Houlahan.

Presented before the Section of Ophthalmology of the New York Academy of Medicine, Dec. 19, 1938.

1. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 2, p. 2006.

tion the epithelium and Bowman's membrane were entirely normal, as was the anterior two thirds of the substantia propria. Beginning in the posterior third, the stroma became increasingly gray and relucent in a suggestively striated manner till Descemet's membrane was reached. No evidence of past or present vascularization was seen anywhere. The posterior surface of the cornea presented a most striking picture. On direct illumination it was seen to be studded with large, irregularly-sized, round and elliptic clear structures, which were more numerous in the pupillary zone. These were also present peripherally up to the limbus (fig.1). When they were observed under low power magnification the first impression was that they resembled "Swiss cheese," but closer study revealed the clear structures to be nodules or thickened depressions rather than vacuoles. Indeed, it was easy to see when the beam was narrowed that at least the larger depressions had a definite convexity toward the examiner and encroached on the stroma. The posterior boundaries of what appeared to be nodules could not be

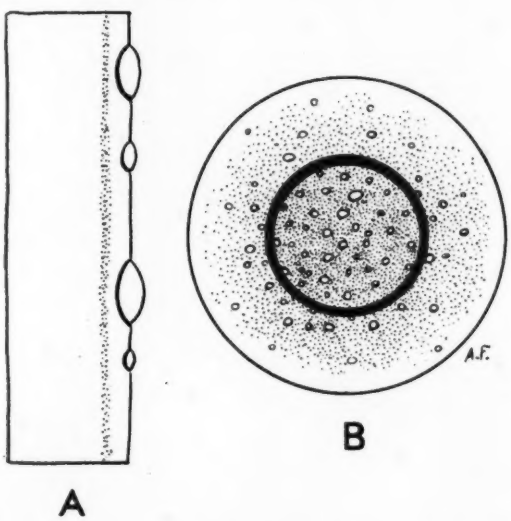

Fig. 1.—Diagrammatic sketch of the lesions in case 1.

seen clearly. The largest of these nodules measured 0.75 mm. in diameter; the average measurement was about 0.2 mm. (fig. 2). The markings of the adjacent stroma were rather relucent and accentuated the clearcut margins. On retro-illumination the nodules appeared as empty spaces. Direct illumination in the zone of specular reflection revealed the endothelium to be completely absent wherever a nodule was present but entirely normal in most other areas (fig. 3). In some places, however, normal endothelium merged into distorted portions, forming whorls of irregular, golden reflections having a mottled pattern. No deposits of any nature were found on the posterior endothelial surface of each eye.

As far as could be determined, it appeared that the structures were excrescences of Descemet's membrane, similar in appearance to Henle's warts but much larger.

On the anterior capsule of the lens of the left eye were a few scattered clusters of star-shaped and v-shaped brown pigment of the type considered congenital.

General Examination.—General physical examination gave essentially negative results. A tendency to a male type of escutcheon was noted. Although the patient

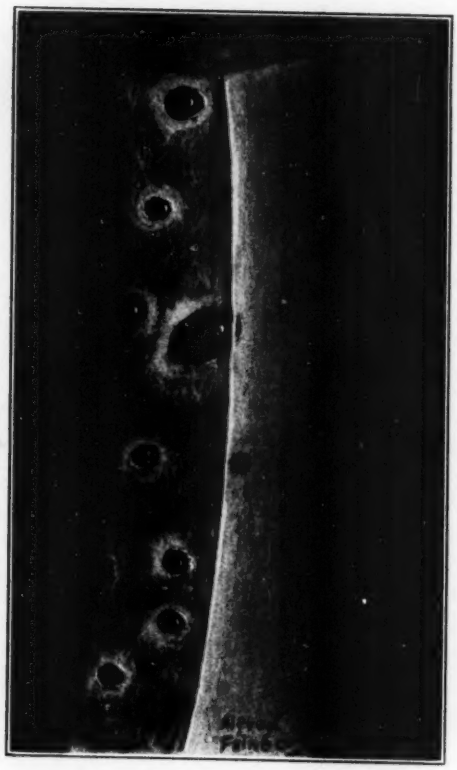

Fig. 2.—Slit lamp appearance on direct illumination in case 1; × 16.

Fig. 3.—Slit lamp appearance on specular reflection in case 1; × 31.

had once been told that she had a pilonidal sinus, no evidence was found on this examination. No other congenital abnormalities were found. In the fall of 1936 she had undergone investigations because of scanty and infrequent menstrual periods. The examination included a study of the endocrine system, which revealed no abnormalities other than a slightly lowered basal metabolic rate, — 16. In the course of a year her periods became practically normal without any treatment. The Wassermann reaction of the blood was negative.

All of the patient's immediate family were then examined. A sister and two brothers were found to be essentially healthy, and their eyes proved to be completely normal. The mother, who had had trouble with her eyes as a child, showed evidences of old eczematous keratitis in each eye. In the central two thirds of each cornea was a superficial opacity. The posterior part of the cornea was entirely normal except for some scattered deposits of pigment on the endothelium, which itself was intact.

Examination of the father, however, requires fuller description.

CASE 2.—Jacob L., 53 years old, the father of the patient in case 1, had never had any trouble with his eyes until a few years prior to examination, when he had begun to have presbyopic symptoms. He had always thought that he could see well, but his visual acuity had never been tested previously.

Ocular Examination.—The vision in the right eye was 20/60; it improved to 20/30 — 1 with a — 0.50 sph. — 0.50 cyl., axis 30. In the left eye it was 20/30 —1 and was only improved to 20/30 + 1 with a — 0.25 sph. — 0.25 cyl., axis 145. With a + 2.25 addition for near vision in each eye he saw the second smallest test type.

On examination each eye was entirely normal except for the cornea. Here, a picture similar to that of his daughter's was present in each eye (fig. 4). Except for a small, superficial corneal scar in the left eye, probably due to an old foreign body, the changes were likewise in the posterior part of the cornea. Parenchymal clouding began diffusely in the posterior third and in the lower portion was accentuated to form an opaque, triangular, wedge-shaped area with its apex toward the center of the cornea, quite similar in appearance to embryotoxon. No vascularization was present. Descemet's membrane was similarly studded with excrescences, as in case 1, but here they were much smaller and tended to be grouped. They measured from 0.08 to 0.12 mm. in diameter on the average. A few measured 0.2 mm. Some showed an anterior convexity. The endothelium was absent behind these areas but intact between them. In the left eye a small amount of brown pigment was present on the endothelium in the center of the cornea, forming a fine horizontal line. The corneal sensation was normal.

General Examination.—General physical examination, as in the case of the daughter, gave negative results. The Wassermann reaction of the blood was negative.

This second case confirmed the congenital character of the anomaly and prompted further study of the father's family.[2] His father, two

2. Dr. Benjamin Sachs, of Boston, allowed me to use his office facilities to study this group of patients.

brothers, two sisters and their six children were found to be completely normal on slit lamp examination. The mother, however, showed corneal changes, which are described in case 3.

Case 3.—Jennie L., a 77 year old housewife, the grandmother of the patient in case 1, had always been healthy until the two years prior to examination, when she had begun to fail in strength. She had never had any miscarriages. She recently suffered from severe headaches, which probably were due to hypertension. Her blood pressure was 230 systolic and 100 diastolic. Her eyes had never bothered her.

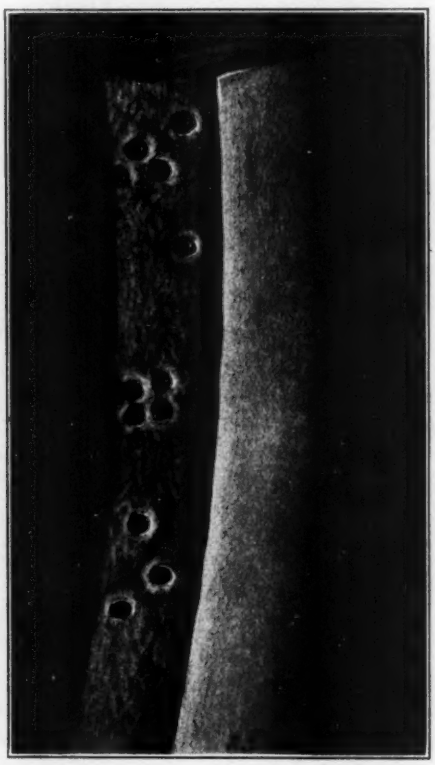

Fig. 4.—Slit lamp appearance on direct illumination in case 2; × 24.

Ocular Examination.—The vision in the right eye was 20/100 and could be improved to only 20/70 with a —75 sph. In the left eye vision was 20/200; it improved to 20/40 + 2 with a + 1.50 sph. — 3.00 cyl., axis 90.

Except for a moderately advanced senile nuclear cataract in the right eye, which caused the visual impairment, and moderate arteriosclerotic changes in the fundus, the only significant ocular findings were corneal. These were bilateral.

Here, as in cases 1 and 2, the pathologic process commenced posteriorly, the epithelium and practically the entire stroma being normal. A little diffuse stippled clouding began just anterior to Descemet's membrane. Scattered, rounded excrescences were found all over Descemet's membrane but were especially noticeable below the center, where they were slightly larger. In the center itself, dis-

tortions of the endothelium, as in case 1, were particularly noticeable, with whorls seen in specular reflection. In this case in contradistinction to the other 2 cases, considerable golden brown pigment was found on and in the endothelium, some of which, at least, appeared intracellular. The nodules were not measured, as no ruled eye piece was available, but they seemed to be somewhat smaller than those in case 2 and much smaller than those in case 1 and were less numerous. The sensibility was unimpaired.

To recapitulate, a daughter, her father and her grandmother, three generations in all, were found to have a bilateral, nodular, anomalous disturbance of Descemet's membrane and endothelium, with impairment of vision proportionate to the degree of pathologic involvement. With each succeeding generation the condition became worse. Except for an increased relucency of the adjacent stroma, the remainder of the ocular examination of each patient gave negative results. General physical examination gave essentially negative results, and no degenerative familial stigmas were present.

REVIEW OF THE LITERATURE

Although it is ignored in the leading textbooks and by most other authors on this subject, the first description of endothelial dystrophy was made by Koeppe [3] in 1916. To the curious structures that studded the posterior corneal surface bilaterally in his six cases, he gave the name of *Dellenbildungen*, translated as "facets" or "pits." The convexity of these structures was toward the observer. The cases were excellently described, and there can be no question that he was dealing with the subject under discussion. All his patients had subnormal vision, which could not be completely corrected. His youngest patient was 25 years old, and the average age of the group was about 35 to 40 years. By 1920 [4] he had collected 18 cases. Sixteen of the patients had normal eyes except for the corneal lesion. Of the remaining 2, 1 had iridocyclitis in one eye only, but both eyes had the "pitting." The other patient had chronic simple glaucoma. The patients stated that their vision had been the same since youth. Therefore, in view of the absence of other pathologic changes, Koeppe concluded that the condition was congenital and was due to an anomaly in the development of the posterior corneal surface.

The second author on this subject was Staehli,[5] who in 1920 described 12 cases in older persons. He spoke of a "bedewing" of the posterior

3. Koeppe, L.: Klinische Beobachtungen mit der Nernst Spaltlampe und dem Hornhautmikroskop, Arch. f. Ophth. **91**:375, 1916.

4. Koeppe, L.: Die Mikroskopie des lebenden Auges, Berlin, Julius Springer, 1920, p. 130.

5. Staehli, J.: Ueber eine besondere Form von Betauung der Kornealrückfläche, Klin. Monatsbl. f. Augenh. **65**:106, 1920.

corneal surface as a manifestation of senile degeneration and named it "dew-drop endothelium." While his descriptions cannot compare with Koeppe's he was the first to point out that the patients were prone to see colored rings around lights, owing to refraction phenomena. Also in 1920 Kraupa [6] wrote a paper associating posterior corneal pigmentation with epithelial dystrophy.

In 1921 Vogt,[7] who usually is credited with priority, reported his observation of this condition, which he later called cornea guttata. He correctly interpreted the excrescences to be similar anatomically to Hassall-Henle bodies and considered the process a senile change. In 1922 Moeschler [8] in a study of posterior corneal pigmentation considered both this and cornea guttata to be due to senile changes. In 1923 Kraupa [9] first mentioned the relationship of the endothelial changes to the epithelial dystrophy of Fuchs.

Undoubtedly the fullest and best anatomic description of the syndrome was published by Graves [10] in 1924. For the first time adequate illustrations appeared. On the basis of the age incidence, he considered the condition a presenile or senile phenomenon. In rapid succession a series of papers by Kirby,[11] who first called the condition "endothelial dystrophy," Triebenstein,[12] who independently gave it the same name, H. and J. S. Friedenwald,[13] Gifford [14] and Sallmann [15] appeared. Influ-

6. Kraupa, E.: Pigmentierung der Hornhauthinterfläche bei "Dystrophia epithelialis (Fuchs)," Ztschr. f. Augenh. **44**:247, 1920.

7. Vogt, A.: Weitere Ergebnisse der Spaltlampenmikroskopie des vordern Bulbuschnittes, Arch. f. Ophth. **106**:63, 1921.

8. Moeschler, H.: Untersuchungen über Pigmentierung der Hornhautrückfläche bei 395 am Spaltlampenmikroskop untersuchten Augen gesunder Personen, Ztschr. f. Augenh. **48**:195, 1922.

9. Kraupa, E.: Die familiären degenerativen Hornhautveränderungen (neurotische Dystrophie und Ichthyosis corneae) in System der sogenannten Dystrophien der Hornhaut, Klin. Monatsbl. f. Augenh. **70**:396, 1923.

10. Graves, B.: A Bilateral Chronic Affection of the Endothelial Face of the Cornea, Brit. J. Ophth. **8**:503, 1924.

11. Kirby, D. B.: Excrescences of the Central Area of Descemet's Membrane, Arch. Ophth. **54**:588 1925.

12. Triebenstein, O.: Veränderung an der Hornhauthinterfläche, Klin. Monatsbl. f. Augenh. **74**:777, 1925.

13. Friedenwald, H., and Friedenwald, J. S.: Epithelial Dystrophy of the Cornea, Brit. J. Ophth. **9**:14, 1925.

14. Gifford, S. R.: Epithelial Dystrophy and Erosion of the Cornea, Arch. Ophth. **54**:217, 1925; Epithelial Dystrophy of the Cornea and Its Relationship to Endothelial Dystrophy, Am. J. Ophth. **9**:81, 1926; The Mild Form of Epithelial Dystrophy of the Cornea, Arch. Ophth. **7**:18 (Jan.) 1932.

15. Sallmann, L.: Ein Fall von Dystrophia endothelialis corneae, Klin. Monatsbl. f. Augenh. **75**:778, 1925; Ueber eine dystrophische Endothelveränderung und Pigmentierung der Hornhautrückfläche, Ztschr. f. Augenh. **58**:348, 1926.

enced by Vogt, they all considered the syndrome to be degenerative, although Kirby mentioned the possibility of a hereditary or familial factor, and the majority of the authors were concerned mainly with the possible relationship to the epithelial dystrophy of Fuchs. By this time the association of endothelial dystrophy with high myopia and glaucoma had been noted, and in 1930 Sallmann [16] published his observation that in 3 cases associated with glaucoma epithelial erosions occurred when he took the tension, indicating the presence of a diseased or more readily damaged epithelium. In this connection Peter's [17] article in 1931, in which he reported that he found signs of cataract in every one of 22 patients, is interesting, as he pointed out that patients with endothelial dystrophy are poor surgical risks.

In 1930 the results of the first histologic study of cornea guttata were published by Vogt.[18] In the second edition of his atlas [19] are excellent illustrations of the biomicroscopic picture and of the histologic specimens. Vogt's observations were confirmed by Goar [20] in 1934. Essentially, the changes consist of irregular thickenings and excrescences of Descemet's membrane. The endothelial cells over these nodules are thinned, even absent, and the cytoplasm contains many pigment granules. The excrescences have staining properties identical with those of Descemet's membrane. Goar expressed the belief that the condition occurs in about 6 per cent of adults, in women four times as often as in men. In 1934, Vogt [21] observed similar changes histologically in another case, and, in addition, it was found that the endothelium was uneven in areas in which there were no excrescences, which would explain the whorl-like appearance seen on specular reflection in the cases described in this paper.

In all the aforementioned reports, with the exception of Koeppe's contributions, it is uniformly agreed that the condition is a senile degenerative change. This conception was challenged by Kraupa,[22] who in

16. Sallmann, L.: Zur klinischen Bedeutung einigen Spaltlampenbefunde an Hornhaut und Linse, Arch. f. Ophth. **125**:62, 1930.

17. Peter, L. C.: Dystrophy of the Corneal Endothelium: Its Recognition and Clinical Significance, Arch. Ophth. **6**:817 (Dec.) 1931.

18. Vogt, A.: Der histologische Befund bei Cornea guttata, Klin. Monatsbl. f. Augenh. **85**:282, 1930.

19. Vogt, A.: Lehrbuch und Atlas der Spaltlampenmikroskopie des lebenden Auges, ed. 2, Berlin, Julius Springer, 1930, vol. 1, p. 99.

20. Goar, E. L.: Dystrophy of the Corneal Endothelium, Am. J. Ophth. **17**: 215, 1934.

21. Vogt, A.: Neue histologische Befunde bei Cornea guttata, Ztschr. f. Augenh. **84**:21, 1934.

22. Kraupa, E.: Ueber Epitheldystrophien der Hornhaut, Wien. klin. Wchnschr. **45**:539, 1932.

1932 reported endothelial dystrophy in three generations, a grandmother of 70, an albinotic daughter of 40 and an albinotic granddaughter of 10.[23] The woman of 40 had the most pronounced changes and pigmentation, while the young girl had less involvement. A few months later Freudenthal [24] reported the condition in a boy of 14 and in his father, aged 42. Both showed a delicate, deep, diffuse parenchymal clouding as well. Because the son showed general changes suggestive of hypothyroidism, although an unsatisfactory basal metabolic test showed the metabolism to be + 20, and the father evidence of general glandular dysfunction, Freudenthal suggested a relationship to general degenerative states. Although the serologic reactions of the blood were negative, he thought that hereditary syphilis might be a factor in causing this endocrine depression, because the father's sister had a 2 plus Wassermann reaction of the blood and an old interstitial keratitis.

The entire subject of epithelial and endothelial dystrophy was then reviewed by Kraupa [25] in 1934. He reaffirmed his contention that endothelial dystrophy is definitely hereditary if not congenital. He offered, in addition, a classification of the epithelial dystrophies which should be mentioned. The outstanding point he made in this connection was that Fuchs' epithelial dystrophy is quite distinct from other types and consists of a general neurotropic disturbance of the entire cornea. According to him, the epithelial changes for which the condition is named are only part of the picture, just one symptom, and the endothelial changes do not occur prior to the rest of the picture in these rare cases, as he had previously thought, but are another part of the general disturbance. One infers from his paper that he believed that the epithelial changes which come on late in the course of endothelial dystrophy belong to an entirely different type of dystrophy. He did not attribute any hereditary character to Fuchs' dystrophy and implied that persons with familial or hereditary histories of dystrophy have the *disjunctio epithelii* of von Szily, which is often misinterpreted as Fuchs' type, or a new type he described under the name of "juvenile epithelial dystrophy," which is of a familial nature. According to Kraupa, these four types are completely confused in the literature, and the condition in many cases has been called Fuchs' dystrophy through error.

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23. The actual description of these cases is found in a later (1934) paper in which Kraupa claims priority over Freudenthal.

24. Freudenthal, E.: Ueber zwei Fälle von familiärer Endotheldystrophie der Hornhaut bei Vorhandensein allgemein degenerativer Veränderungen, Ztschr. f. Augenh. **78**:224, 1932.

25. Kraupa, E.: Ueber Epithel- und Endotheldystrophien, Ztschr. f. Augenh. **83**:179, 1934.

Further reports mentioning the relationship of epithelial to endothelial dystrophy were made by Biozzi [26] and Sala [27]. In 1935 Horniker [28] in a study of patients with endothelial dystrophy or posterior corneal pigmentation commented on the frequency of the conditions and concluded that they are due to a disturbance of the neurovegetative system and are manifestations of a special angioneurotic constitution. He found patients with circulatory disturbances, neuroarthritis, hemicrania and scintillating scotomas. The allergic character he thought proved by the occurrence of urticaria, hay fever, mucous colitis, angina pectoris (!) and asthma in some of these patients.

The most recent paper to appear on the subject is that of Motolese [29] in 1938. He described a case of endothelial dystrophy in a man with pulmonary tuberculosis. The father had syphilis, and some siblings had pulmonary tuberculosis. In the course of six years a "typical" Fuchs' epithelial dystrophy occurred in each eye. The vision in one eye, however, improved during this period. The other eye became practically blind. He expressed the belief that the corneal condition became worse as the patient's general condition became poorer. As far as the endothelial dystrophy is concerned, his failure to describe it adequately until the last examination is to be regretted. Motolese concluded that endothelial dystrophy may be found in patients of any age or perhaps congenitally and is due to a disturbance of a general nature or changes such as Horniker described. His otherwise complete paper does not dwell enough on the evidence for these statements. He also described 2 cases of familial juvenile epithelial dystrophy similar to those of Kraupa, to which group Curin [30] in 1937 had added a case of the congenital type.

COMMENT

The cases reported in this paper are notable because in three generations a similar, dystrophic condition of Descemet's membrane and of the endothelium appeared. In each succeeding generation the condition was more pronounced. There is no question of the hereditary character of the changes. Nor can there, likewise, be any reasonable doubt as to the

26. Biozzi, G.: "Cornea guttata" e reperti associati, Arch. di ottal. **41**:357, 1934.

27. Sala, G.: Opacità a cintura e cornea guttata, Rassegna ital. d'ottal. **3**:860, 1934.

28. Horniker, E.: Le distrofie endotheliali della cornea ed il loro significato, Atti d. Cong. Soc. oftal., 1935, p. 199; abstracted, Zentralbl. f. d. ges. Ophth. **35**: 690, 1935-1936.

29. Motolese, A.: Distrofie epiteliali ed endoteliali della cornea, Boll. d'ocul. **17**:1, 1938.

30. Curin, J.: Die "juvenile Epitheldystrophie," Ztschr. f. Augenh. **91**:185, 1937.

congenital origin in the first case. The cloudiness of the cornea was noted at birth and was confirmed by ophthalmologists at the age of 3 months. The patient's vision was poor from infancy and did not change. While one cannot be as certain in the case of her father, since he was older and did not have enough visual impairment to notice it, it appears likely that he, too, was born with the condition. The triangular, wedge-like segment described had definitely the appearance of a congenital lesion. As regards the grandmother, although there was no history to go by, one can only surmise that she, too, was born with the condition.

The next question is whether the conditions in these cases belong in the category of endothelial dystrophy. In the light of what a complete review of the literature reveals about the syndrome, one is justified in classifying them as such. The character, location, and distribution of the lesions are essentially the same. In only the first case does the picture differ at all from that in the previously reported cases. The nodules (average, 0.2 mm.; some 0.75 mm. in diameter) are so much larger than usual (from 0.04 mm. to 0.08 mm.) that, at first glance, they might seem different. Actually, the difference is only quantitative.

The question of the direction of the convexity of the nodules, although apparently only a detail, gives rise to interesting speculation. The larger nodules seen in cases 1 and 2 had an anterior convexity. Vogt and Graves, who expressed the belief that the condition is senile, described the nodules as having a posterior convexity, i. e., toward the anterior chamber. This corresponds with the pathologic picture and would seem logical if the nodules appeared after the complete development of the cornea, such as after birth, since extension would most likely occur in the direction of least resistance—toward the endothelium rather than toward the tougher stroma. But if the nodules were large enough and the original disturbance occurred early enough in the embryo, the stroma might be encroached on, in fact, be partially deficient at these sites. Descemet's endothelium is present at the 20 mm. stage, and Descemet's membrane is definitely present at 76 mm. The parenchymal development is not complete till much later. Thus, it is not too difficult to imagine the nodule being present before the stroma is in a final state of development and so having an anterior convexity as well as a posterior one. In further support of this theory is the fact that in the 3 cases here presented, as well as in Freudenthal's cases of the congenital type, the posterior portion of the stroma showed clouding and diminished transparency. That this should occur when the smooth and even arrangement of the fibers of the stroma is irregularly impaired by the proturberances seems reasonable; in fact, it is even to be expected. Moreover, the increased relucency is of a striated type. Koeppe, the proponent of the congenital nature of the condition, also described an

anterior convexity to the nodules. Kraupa, who expressed the same opinion as regards the congenital nature, thought that the nodules had a posterior convexity. His own cases are not fully described, and it is possible that the nodules were small. Freudenthal omitted any mention of this detail entirely. I could not find a definite anterior convexity in my third case in which the nodules were small. Thus, it seems likely that the biconvexity of many of the nodules is a corollary to their large size and to their appearance early in embryonic life.

Another speculative point is raised by the fact that in the cases of the definitely congenital type no evidence of epithelial change occurred, even in the 77 year old woman whose case is reported here and the 70 year old female patient of Kraupa. The incidence of endothelial dystrophy is high and that of epithelial dystrophy low, and the relationship may be accidental, as some still believe; but it may be significant that in the cases reported here no relationship was found to exist, while in cases of the senile type the two conditions are sometimes found together. Motolese did not consider the condition in his case of congenital origin. Moreover, some authors, notably Vogt and Graves,[31] described the condition in their cases of pure endothelial dystrophy of the senile degenerative type as progressing in the course of time, with diminution of vision. The condition in the cases of proved congenital origin and in those cases in which one may assume the origin to be congenital seems to show no such progression, and the vision is stationary. This is what one would expect of a congenital anomaly. Moreover, in the cases reported here the youngest patient had more pathologic involvement than the oldest.

While the differences suggested here are only conjectures and not presented as valid arguments, a study of the subject leads to the conclusion that there may really be two types of endothelial dystrophy, one a senile change of frequent occurrence, sometimes associated with epithelial dystrophy, and the second, a congenital form. Similar excrescences of Bruch's membrane are known to occur in these two forms. It is unfortunate that the early work of Koeppe was so routinely disregarded by all authors, influenced as they were by Vogt's contributions, except Kraupa and Motolese. The occurrence of the congenital type cannot be doubted. But it appears rather illogical to assume, as Kraupa does, that the condition is congenital in all cases because it is in some. The great majority of the observers noted the condition in elderly persons, and while it may be true that they might have been more carefully studied than younger persons and thus the condition more readily discovered, the fact remains that most of the cases of endothelial

31. Graves, B., in Berens, C.: The Eye and Its Diseases, Philadelphia, W. B. Saunders Company, 1936, p. 474.

dystrophy are found in elderly persons. Of course, had Koeppe's conception been considered, much of the work might have been done from a different point of view. However, only after large groups of children are shown to have this disturbance as frequently as their elders can the proponents of the purely congenital nature of the abnormality be truly certain. Until then, it seems safer to assume that endothelial dystrophy has at least two forms, one due to developmental changes and the other due to senile degeneration.

CONCLUSIONS

Three cases of endothelial dystrophy occurring in a daughter, her father and her grandmother are described. The condition in these cases must be classified as of congenital origin. A review of the literature reveals that some authors consider the condition to be congenital, while the great majority believe it to be a senile degenerative change. On the basis of evidence at my disposal and some apparent differences noted in the two types, it is suggested that endothelial dystrophy be considered to have two forms, one congenital and the other senile.

ADDITIONAL RESEARCH ON VERNAL CONJUNCTIVITIS

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Vernal conjunctivitis is a specific form of ocular disease. It is seasonal in character, beginning in the spring, and is characterized clinically by itching, lacrimation, photophobia, a bloodshot appearance and a mucous discharge, often containing eosinophils. It occurs chiefly in children with a past or present history of some allergic disease and in members of families in which other allergic diseases occur. It responds symptomatically to treatment with epinephrine.

DESCRIPTION OF DISEASE

Beginning as early as the pollination period of the trees in April or later in the spring coincident with the pollination of the grasses or at any time in the late spring and early summer, vernal conjunctivitis may continue through the hot season until the first cool weather in September.

There are two distinct varieties of the disease, the limbic, or corneal, type and the lid, or palpebral, type. They differ in their appearance by reason of the anatomic locations of the lesions, the limbic type being of shorter duration, lasting only for the seasonal attack and leaving no telltale pathologic involvement, while the lid type, after one or more seasonal attacks, may continue to manifest pathologic lesions throughout the year, but with an absence of symptoms during the cold season. The lid type is always characterized by stringy, chewing-gum mucus, while in the limbic form the mucus is less viscid and much less in quantity.

The characteristics of the objective symptoms have been reported in earlier publications. Suffice it to say that the limbic type maintains itself as single, discrete, phlyctenular-like elevations at the limbus, attended by vascularization, or in the form of confluent phlyctenules, two, three or more, or a complete or incomplete ring of icing effect at the limbus.

Read in part before the Section on Ophthalmology, College of Physicians, Philadelphia, Feb. 16, 1939.

These elevations are found only in the acute stage of the disease; they reach their height in about two or three weeks and then, like the wheals of urticaria, slowly recede. Because of the hyperemia of the conjunctiva, both bulbar and palpebral, there will be noticed follicular enlargements resembling the simple type of palpebral vernal conjunctivitis. It is this manifestation coincident with the limbic type which gives the often mistaken impression that the limbic and the lid types may occur at the same time. From experience, however, the limbic type and the lid type never occur coincidentally in the same patient.

The lid types are divided into: (1) the simple follicular type, (2) the pavement epithelium (cobblestone) type and (3) the granuloma or giant cobblestone type.

For a further description, the reader is referred to a previous article by one of us (L. L.).[1]

OPHTHALMIC AND INTRADERMAL TESTS

The present study was made in an effort to determine whether or not vernal conjunctivitis is truly an atopic disorder due to pollens and other atopens or whether it is due to some extraneous nonspecific agent or to some agent with which the eye comes in contact.

The tree pollen extracts used for both the intradermal and the ophthalmic tests were those of the nine common trees—ash, beech, birch, elm, hickory, maple, oak, poplar and sycamore. Other pollens utilized were those of the grasses and weeds—timothy, plantain and ragweed. Allergens used for the intradermal tests consisted of the common inhalant group and foods, such as vegetables, fruits, cereals, fish, meat, dairy products, nuts and spices.

Many patients referred to us were excluded from the present series, as they constituted seasonal hay fever sufferers with ocular symptoms predominating. Physical examination failed to reveal any endocrine disorders or physical maldevelopments.

Diagnosis was based on a careful detailed history, personal and family histories for allergy, eosinophils in the discharge from the eye and in the blood, seasonal incidence, positive reactions to the ophthalmic and intradermal tests and the clinical ocular findings.

The intracutaneous method of testing was employed in this series of cases. We made use of the intradermal rather than the scratch method, it being more accurate and sensitive, and we preferred obtaining a false positive reaction rather than miss any reaction that we otherwise would if the scratch test were used. All extracts were freshly prepared, and their strength was based on the total nitrogen content as determined

1. Lehrfeld, L.: Vernal Conjunctivitis: Observations on Eighty-Seven Cases at the Wills Hospital (1929-1931), Arch. Ophth. **8**:380-404 (Sept.) 1932.

by the Kjeldhal method. The tests were performed on the outer aspect of the arm, which was first cleansed with 70 per cent alcohol. A 1 cc. syringe graduated by hundredths was used. The needles were 26 gage and ⅜ inch (0.9 cm.) in length. All intradermal injections were made as superficially as possible. Enough of the antigen was introduced to produce a wheal, which in no case exceeded 1 mm. Controls of buffered saline solution were used in all cases. The reactions were read in from ten to fifteen minutes after injection and classified into marked, moderate, slight, doubtful and negative.

DEGREES OF POSITIVE REACTIONS

A marked reaction was one in which a large wheal was obtained, usually of 10 mm. or more, with pseudopod formation and projection into the surrounding zone of erythema. This reaction was usually accompanied by itching. A moderate reaction consisted of a definite increase in the size of the wheal but without pseudopod formation. There was a definite zone of erythema, and itching was sometimes present. A slight reaction consisted of a slight increase in the size of the wheal, with a surrounding zone of erythema. A doubtful reaction was one that was slightly larger than the control reaction. Patients with doubtful reactions were always retested on another day. The sensitivity of the skin was always taken into consideration. No delayed reactions were considered.

Keeping in mind that a positive reaction to the intradermal test is only an index of cutaneous hypersensitivity, we attempted to correlate these findings with the reaction to the ophthalmic test. This test consists of the introduction into the lower cul-de-sac of dry pollen or antigen by means of the pointed end of a toothpick. The reactions thus obtained are read in from three to five minutes and again at the end of a ten minute period. A positive reaction consisted of intense immediate congestion of the bulbar and the palpebral conjunctiva and of the caruncle. All positive reactions were controlled by the instillation of a solution of epinephrine hydrochloride in a concentration of 1 : 1,000. Pine pollen was used as a control. (Pine is not an excitant.)

Passive transfer tests were not done in the present series, so that the presence of reagins could not be determined. Conjunctival smears and blood examinations were made for eosinophils. Patch tests were performed on a small series of the group but were persistently negative.

RESULTS

Of the 120 patients who were studied, 40 of 109 gave a family history of allergy. Thirty-seven of these had a history of allergy on one side of the family and 3 had a history of allergy on both sides of the family. There were 69 with no history of allergy. While this figure

may be slightly lower than that for patients with hay fever and asthma, it stresses the importance of the influence of heredity in vernal conjunctivitis (table 1).

The individual atopic diseases affecting the subjects studied included asthma, hay fever, atopic eczema, migraine and urticaria. Thirty-six of the 92 patients under observation gave a history of atopic disease (table 2).

The ages for this series of patients varied from 1 year to 56 years. There were 82 males as compared to 38 females. The group included 30 Negroes. Sixty-five of the 120 patients were under 10 years of age, while 48 were between the ages of 11 and 30 years. Here again the age incidence is highly significant, for it is commonly agreed that the greater

TABLE 1.—*Family History of Atopic Disease*

	Number of Males	Number of Females	Total Number
Unilateral			
(a) Maternal	16	9	25
(b) Paternal	10	2	12
Bilateral	2	1	3
Negative	46	23	69

TABLE 2.—*Personal History of Atopic Disease*

Disease	Number of Males	Number of Females	Total Number
Asthma	7	1	8
Hay fever	6	2	8
Atopic eczema	5	3	8
Urticaria	8	2	10
Migraine	1	1	2
Negative	..	..	58

the inheritance the earlier the age of onset of allergic symptoms. The sex incidence is again similar to that for other allergic conditions, for which it is found that in the first decade the males usually predominate over the females.

There were 31 cases of the lid type and 89 of the limbic type. In a previous report by one of us (L. L.) a little more than half of the total of 87 cases were of the lid type and the remainder were of the limbic type. The preponderance of males over females and of one type as compared with the other type depends on the season under study. It is the experience of one of us (L. L.) that considering several seasons jointly, the lid type is far in excess of the limbic type. The explanation is that the lid type has a much longer duration in number of seasons than the limbic type. It is common to see an accumulated group of cases of the lid type over many seasons, while the number of cases of the limbic type in which the condition is of one, two or three seasons'

duration shows a tendency to wane in comparison with the other type. Our joint experience, however, indicates that there are more male patients than females. The Negro subjects were found to manifest the limbic type only (table 3).

Of 46 patients tested by the intradermal method with the inhalant group 44 gave positive reactions to one or more agents of the group (table 4).

TABLE 3.—*Incidence of Vernal Conjunctivitis—Sex, Age and Race*

	No.	0-5	6-10	11-15	16-20	21-30	31-40	41-50	51-Over	Negro	White
Both types											
Male.....	82	26	24	16	5	10	1	0	0	21	61
Female.....	38	7	8	6	7	4	4	1	1	9	29
Total.....	120	33	32	22	12	14	5	1	1	30	90
Limbic type											
Male.....	57	18	17	10	3	8	1	0	0	21	36
Female.....	32	5	6	6	5	4	4	1	1	9	23
Total.....	89	23	23	16	8	12	5	1	1	30	59
Lid type											
Male.....	25	8	7	6	2	2	0	0	0	0	25
Female.....	6	2	2	0	2	0	0	0	0	0	6
Total.....	31	10	9	6	4	2	0	0	0	0	31

TABLE 4.—*Results of Intradermal Tests with Inhalant Group*

	Number of Tests	Number of Positive Tests	Number of Persons Tested	Number of Reactors
Lid type.....	194	71	14	13
Limbic type.....	403	123	32	31
Total.....	597	194	46	44

TABLE 5.—*Results of Intradermal Tests with Grasses and Weeds*

	Number of Tests	Number of Positive Tests	Number of Persons Tested	Number of Reactors
Lid type.....	126	37	21	14
Limbic type.....	362	72	61	35
Total.....	488	109	82	49

Eighty-two patients were tested with the grasses and weeds, with 49 positive reactors (table 5).

Of the 46 patients tested with the pollens of the trees, 34 reacted positively (table 6).

Of the inhalant group, the most frequent antigens causing a positive reaction were dust and feathers. Thirty-three of 40 persons reacted to house dust; 15 of 36, to feathers. Next in frequency were silk, tobacco,

wool, goat epithelium, orris root, kapok and Pyrethrum. Fifty-three patients were also tested with the combined food and inhalant group, of which 52 showed positive reactions (table 7).

TABLE 6.—*Results of Intradermal Tests with the Pollens of Trees*

	Number of Persons Tested	Number of Reactors	Number of Tests	Number of Positive Tests
	0.1 Mg. of Total Nitrogen			
Lid type	5	5	45	25
Limbic type	15	14	135	64
Total	20	19	180	89
	0.01 Mg. of Total Nitrogen			
Lid type	13	9	117	36
Limbic type	13	6	117	24
Total	26	15	234	60

TABLE 7.—*Results of Intradermal Tests with Foods and Inhalant Group*

	Number of Persons Tested	Number of Reactors	Number of Tests	Number of Positive Tests
Lid type	16	16	879	304
Limbic type	37	36	1,634	517
Total	53	52	2,513	821

TABLE 8.—*Results of Ophthalmic Tests with Pollens of Trees, Grasses and Weeds*

	Number of Persons Tested	Number of Reactors	Number of Tests	Number of Positive Tests
Total	102	46	582	103

TABLE 9.—*Data on Conjunctival Smears Showing Eosinophils*

	Number of Smears Taken	Number Showing Eosinophils	Highest Count, Percentage
Lid type	18	17	96
Limbic type	49	21	78
Total	67	38	

TABLE 10.—*Data on Blood Smears Showing Eosinophils*

	Number of Smears Taken	Number Showing Eosinophils	Highest Count, Percentage
Lid type	15	10	22
Limbic type	22	10	18
Total	37	20	

Of the 102 persons on whom the ophthalmic test was performed with the dry pollen of the grasses, trees and weeds, 46 gave positive reactions. In a total of 582 ophthalmic tests, 103 positive reactions were obtained (table 8).

A total of 67 conjunctival smears were taken. Of this number, 38 showed a proportion of eosinophils greater than 4 per cent. These smears represented 18 cases of the lid type and 49 of the limbic type. The highest count was 96 per cent in the lid type and 78 per cent in the limbic type (table 9).

Blood smears were taken for 37 patients (table 10). Twenty showed a proportion of eosinophils over 4 per cent, the highest value being 22 per cent for those with the lid type of conjunctivitis and 18 per cent for those with the limbic type. Fifteen of the 37 patients had the lid type of the disease and 32 the limbic type.

COMMENT

We are here concerned primarily with evidence that this disease resembles in many ways other atopic states. The shock tissue is the ocular conjunctiva, while in hay fever it is the nasal mucous membrane; in chronic asthma, the bronchial mucous membrane, and in eczema and urticaria, the epidermis. As an atopic disease, vernal conjunctivitis is a form of hypersensitiveness subject to the influence of heredity. We have shown that heredity plays an important part in this disease and that the age factor corresponds to the age incidence of other atopic disorders. By laboratory tests, both intradermal and ophthalmic, we have shown a percentage of positive reactions comparable to those found in other allergic diseases. Vernal conjunctivitis in our series was shown to exist in the same family and also in members of families in which other atopic diseases were present. The similarity of the pathologic process and symptoms of this disease to those of other atopic states is evident.

The periodicity and seasonal recurrence of vernal conjunctivitis are definitely proved facts. Patients with vernal conjunctivitis, like many atopic subjects, have distress manifested mostly in the evening, just as does the asthmatic person and those affected with urticaria and eczema. The picture is much like that of pollen hay fever in which at first there are paroxysmal seasonal attacks, which gradually become complicated by seasonal asthma, become prolonged each year, continue after the pollinating season and finally become perennial without reference to any particular pollen.

Vernal conjunctivitis of the lid type resembles pollen hay fever in that there are seasonal attacks, each season adding to the pathologic involvement, with an aggravation of symptoms, until there develops a perennial pathologic condition with but seasonal symptoms. By this is meant that the simple follicular type develops into the cobblestone type, and the pathologic process may be recognized in the winter months with or without mucous discharge and with symptoms of itching only when the patient is exposed to heat or to some offending substance with which

the eyes may come in contact. The occasional symptoms during the winter are due to the persistency of the pathologic process and the complication by allergens other than those found during the seasonal attacks.

It has been definitely established that there is a specific local hypersensitiveness of the conjunctiva in tuberculosis and hay fever as demonstrated by the ophthalmic reaction—a specific sensitization without a constitutional reaction. In vernal conjunctivitis this sensitization has also been demonstrated as a result of an allergen coming into contact with the sensitized cells.

We do not regard this as a contact conjunctivitis. In the contact allergies the oil fraction of the antigen is of prime importance. Repeated patch tests, although not recorded in our results, have been performed on many of our patients and have been consistently negative. Further investigation with the patch tests along this line of endeavor is desirable. (This particular part of our research was suggested by Dr. Louis Tuft, chief of the allergy clinic, Temple University.)

In the process of our work other problems presented themselves to us, which, owing to insufficient time, could not be carried out. These problems consist of determining the effect of an air-conditioned room on patients with vernal conjunctivitis, including the effect of temperature and humidity, and the effect of the removal and introduction of various pollens, antigens and molds. (All patients who attended air-conditioned theaters reported prompt relief from ocular symptoms.)

The study of molds and fat-soluble excitants comprises a study in itself, and the effect of physical agents, such as light or photosensitivity, is another problem to be presented in the future.

SUMMARY

There is a definite family or personal history of allergy in patients with vernal conjunctivitis comparable with other forms of atopy.

There is a definite seasonal incidence.

The age group and sex incidence correspond to those found for other atopic states.

Laboratory studies reveal a large proportion of positive intradermal and ophthalmic reactions to the pollens and other antigens.

There is a definite increase in the eosinophils of the blood and a demonstration of these cells in the ocular discharge.

Epinephrine hydrochloride instilled in the eyes gives temporary relief from subjective symptoms.

There is a specific local hypersensitiveness of the conjunctiva without constitutional reaction.

The similarity between vernal conjunctivitis and other atopic diseases is striking.

AIDS IN THE FITTING OF CONTACT LENSES

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The fitting of contact lenses can be expedited by a saving of time and trouble in the determination of the visual curve. The usual procedure requires measurement of the radius of curvature of the anterior corneal surface with the ophthalmometer and determination of the apparent axial refraction of the eye by neutralization of the patient's spectacle lens. Whenever astigmatism is present the radius of either one of the principal corneal meridians as well as the axial refraction of the eye in that same meridian must be measured. Application of these two measurements to either the graph or the scale supplied by the Zeiss Company will give the approximate required curve for the inner surface of the corneal segment of the contact lens. An afocal contact lens with this corneal radius is then placed over the eye. Finally, additional spherical lenses are placed before the eye in a trial frame until the proper visual correction is obtained. The final prescription will likely specify this corneal curve plus the additional spherical power, if any, that was added in the trial frame.

The procedure just described can be shortened by the elimination of the ophthalmometric determination and by the substitution of an instantaneous formula for the graph and table. Also, additional spherical power in a trial frame can be converted rapidly into an equivalent larger or smaller corneal radius in the contact lens.

Two formulas, one for myopic patients and the other for hypermetropic patients, were obtained in the following manner from the data secured by examining 152 patients for contact lenses. Two series of points, one for persons with myopia and the other for those with hypermetropia, were plotted on cross section paper. The abscissas were made to represent the total amounts of refractive power, in diopters, in the patients' spectacle lenses; the ordinates were made to indicate the corneal radiuses of the corresponding correcting contact lenses. The total amount of refractive power in a spectacle lens means the cylindric component added algebraically to the spherical component. It was assumed that the spectacle lenses were correct if they gave vision of 20/25 or better and if they were comfortable. An average locus of all of these points was drawn. For both groups of patients it was found to be a straight line. This made it easy to obtain an equation expressing the relation between the amount of refractive error and the required radius

of curvature for the corneal segment of the correcting contact lens. From analytic geometry it is known that a straight line is determined by two of its points and that the equation of a line passing through two given points P_1 (x_1, y_1) and P_2 (x_2, y_2) is:

$$\frac{y - y_1}{x - x_1} = \frac{y_1 - y_2}{x_1 - x_2}$$

By substituting the actual values of two of the points in the line in this equation in each case, two approximate empiric formulas were obtained.

For myopia, the following formula is applicable:

$$y = \frac{x + 30}{4}$$

In this formula y is the radius of the corneal portion of the contact lens, expressed in millimeters, and x is the total minus power, expressed in diopters, in the patient's spectacle lens (spherical moiety is added algebraically to the cylindric). This formula will give the radius of curvature for the corneal segment to within 0.3 mm. in almost every instance. This is surprisingly accurate when it is realized that many persons with myopia wear glasses which overcorrect to varying degrees.

An interesting and useful correlation was observed between additional spherical power as provided by lenses in a trial frame and the equivalent effect produced by changing the radius of curvature of the corneal portion of the contact lens. It was found that a spherical addition of 0.5 diopter produced the same effect as changing the radius of curvature by 0.1 mm. Instead of adding x diopters of plus or minus sphere in a trial frame in front of a contact lens, one can obtain the same visual effect by changing the radius of curvature by 0.2 x millimeters, adding this amount to the radius of curvature when the additional power is minus and subtracting it when the additional power is plus. For example, if a patient is wearing a contact lens with a corneal curve of 8.3 and it takes an additional minus sphere of 1.5 diopters power to improve the vision to 20/20, the required curve for the corneal part of the contact lens is 8.6. If a lens with this curvature is available in the trial case, it then can be inserted and the patient will see just what the final visual result will be. Likewise, if a plus 2.0 diopter additional sphere gives better or more comfortable vision to a person with hyperopia wearing a well fitting trial contact lens of 12.0/6.8 size, the final lens may be ordered as 12.0/6.4 to obtain the same visual result.

The empiric formula for quickly determining the corneal radius of a contact lens has already been given for myopia. The formula for hypermetropia is given only tentatively and with some hesitation, as it probably is not based on enough cases, only 41. Also, hyperopia is much less uniformly dealt with by oculists than myopia. Some ophthalmologists give full correction; others prescribe a minimum correction. Thus.

in hypermetropia the ciliary muscles do varying amounts of the work, and any formula, regardless of the number of cases on which it might be based, would be less exact than a formula for myopia. Therefore, the following formula should be regarded merely as a rough guide:

$$y = \frac{34 - x}{4}$$

In this formula y equals the radius of curvature, expressed in millimeters, of the corneal segment of the correcting contact lens; x equals the total plus power, expressed in diopters, in the patient's spectacle lens, the spherical and cylindric components having been added algebraically.

Similar plottings were made to discover any possible relation between the scleral curves of the correcting contact lenses and the amount of ametropia corrected by the spectacle lenses. No true correlation was found. Only a few generalities were observed. The scleral curves ranged in size from 11.4 to 13.2. Persons with myopia require only a slightly larger average curve than those with hypermetropia. Eighty per cent of those with myopia need a curve of 12.0 or larger, the most probable one being 12.6. For myopia of 5 diopters or more, a curve of 12.2 or larger probably will be needed. The majority of persons with hyperopia need a curve in the range between 11.8 and 12.5, with 12.0 as possibly the most likely curve for the scleral segment.

LOUIS ÉMILE JAVAL

1839-1907

A CENTENARY TRIBUTE

JAMES E. LEBENSOHN, M.D., PH.D.
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Javal had a genius for an infinite capacity for work. He was inspired in youth by the life and achievements of Benjamin Franklin; and the portrait of this guiding spirit ever after graced his study, and Franklin's admonition that "time is the stuff life is made of" became a motto, ever to be remembered. Javal himself was of the Franklin type and emulated his ideal in consistent industry and manifold interests; for Javal was not only an ophthalmologist but a legislator, journalist, educational leader, hygienist and social reformer.

When in 1806, at the suggestion of Napoleon, the Jews of France changed their oriental patronymics to the type of surname used by the rest of the French citizenry, Javal's grandfather inscribed his name Jacob on the register. This was miscopied by the clerk as Javal and became the family name thereafter. Leopold, Javal's father, was an associate of the celebrated financier Jacques Laffitte and for fifteen years was a deputy to the national assembly. In 1838 he married Augusta de Loemel, the cultivated daughter of a leading banker in Prague. Imbued with the idea of progressive education expounded in Rousseau's "Émile," she named her first child (the subject of this sketch), born on May 5, 1839, after the book and reared him by its tenets.

TRAINING

Émile Javal derived from his father the spirit of enterprise, from his mother a devotion to service and from both a keen intellect. Not for him the gay life of a rich man's son; his way was rather that of the practical idealist, zealous in work, simple in tastes, easy of access. A sincere friend, he was rewarded with the lasting friendship of many destined for high places. Among these were his classmates at the *lycée*, the brothers Carnot and Sully-Prudhomme, the poet, who later dedicated to Javal some of his charming verses.

From the Department of Ophthalmology, Northwestern University Medical School.

Javal inclined to a scientific career and could not be persuaded to follow his father's footsteps. He originally preferred medicine but, bowing to family opposition, compromised on mining. After his graduation at the age of 23, he spent a year in observing the principal mines of Europe and then accepted an engagement in the coal mines controlled by his family. Sundry innovations which he then proposed were rejected but later were introduced with success, a tribute to his insight.

Javal's interest in physiologic optics was aroused by several circumstances. His father had a convergent squint, for which Desmarre operated when Émile was 7 years of age. The result was a disfiguring divergent squint, which rendered the sympathetic family desolate. Javal's sister, Sophie, 15 years his junior, inherited the father's anomaly, a misfortune which later affected his brother's two children. Von Graefe, visiting Paris, was consulted by the father, and young Javal was profoundly impressed by the great personality. Javal himself had a minor ocular abnormality; one eye was blue, the other brown. Moreover, reading at night produced discomfort. A disciple of Donders dismissed his refractive error as "physiologic astigmatism," but Javal, while experimenting with a cylinder that he chanced to pick up, noted a definite improvement of vision. Perhaps there was a need for more refined methods for accurately determining astigmatism. The Brewster stereoscope, invented when Javal was 10, became one of his most vivid childhood memories. Perhaps it could be used to develop the faculty of binocular vision. These two problems immediately challenged his attention. His first studies, published in the *Presse scientifique des deux mondes,* received such encouraging attention that he abandoned mining, which he had practiced for a year, and enrolled in 1865 in the school of medicine of the University of Paris.

ACHIEVEMENT

Javal embarked on his new career with a display of amazing industry. Before he graduated he had improved the optometer and contributed sixteen articles on astigmatism and orthoptics to journals of ophthalmology. A linguist, able to speak French, English, German and Italian, and to read Spanish, Portuguese, Dutch and Latin, he sought to popularize in France the master works of Donders and Helmholtz. The 1864 English edition of Donders, translated with the aid of Debove, Rendu, Monoyer and Hunt, an American, appeared in 1866. At the suggestion of Gavarret, his professor in medical physics, Javal next proceeded, with the cooperation of Klein, to the translation of the work of Helmholtz, translating the last section from the manuscript, so that the French version and the completed German text were published

simultaneously in 1867. In this same year, Javal, then 28, married Maria Ellisen, of Frankfort. The following year, Javal graduated; his thesis, honored by a silver medal, was entitled "Du strabisme dans ses applications à la théorie de la vision." Javal then hurried to Berlin and imbibed the wisdom of ophthalmology from von Graefe, till his stay was interrupted by the Franco-Prussian War. He returned to France with his wife and 9 month old child and immediately volunteered as a medical officer for the service of his country.

After the war Javal became absorbed in civic issues, education and social reform. He followed his father's lead in politics and for twenty-four years represented his canton and for five years (1884-1889) was

Fig. 1.—Louis Émile Javal. (From Ann. d'ocul., 1938, vol. 175.)

deputy from his department. Javal opposed the French construction of the Panama Canal and prophesied disaster for the project. Fearful of depopulation, he sponsored a law relieving families of seven from all direct taxes. Though the Javal law remained in force but a year, exemption privileges of similar pattern have been lately reconsidered. The influence of Javal's studies on the factors affecting population is reflected also in the novels of Zola. An ardent advocate of adult education, he was, with Camille Flammarion, among the charter members of an association for the popular diffusion of scientific knowledge and for many years was its president.

Javal's inability to secure an appointment to the department of ophthalmology of the University of Paris dampened for a time his scientific

enterprise. But in 1878 his old teacher, Gavarret, persuaded the faculty of general physiology of the Sorbonne to establish under its control a laboratory of ophthalmology and to name Javal its first director. The laboratory started as a single room with meager appointments. The famous library of Sichel, consisting of 8,000 precious volumes from the previous three centuries, was purchased from the heirs by Javal and presented to the institution. One of Javal's earliest co-workers was Schiötz, and in 1880 the two began work on the simplification of the ophthalmometer. Tscherning joined them in 1884. The laboratory soon achieved international recognition. Among those attached to its staff were Landolt, the elder Nordensen, Ericksen, Leroy, Sulzer and Bull, an American. Javal had justified his leadership, and in 1884, at the age of 45, he was elected a member of the Academy of Medicine, a signal honor for an ophthalmologist. Just then, at the height of his career, came the threatening symptoms of his eventual amaurosis; this but spurred him to give to the world in definitive form his knowledge of astigmatism, orthoptics, visual hygiene and blindness.

Javal's enthusiasm for ophthalmology centered in optics, and his practice was restricted mostly to refraction and squint. As he was of independent means, his office provided material for private study rather than a source of income. If a patient proved interesting, he would waive the fee and invite him to dinner. Once a month he visited the villages in his canton and gratuitously gave his services to the indigent, a tradition which Tscherning generously continued, but otherwise Javal never conducted a clinic. Uninterested in surgery, he referred all operative interventions to his colleagues.

Every phase of practical optics excited Javal's interest. A vexatious lawsuit followed a report in which he deflated the advertised claims of some lenses made of baryta glass. An enlightened court was fortunately for scientific freedom. Javal's earnest support hastened the general adoption of the dioptric enumeration proposed by Monoyer. The translucent test chart used with a mirror was his device. It was also his suggestion that plus and minus lenses be distinguished in trial cases by silver and gold rims, respectively, silver for the silver hair of presbyopia.

After Young made his discovery of astigmatism, the use of the optometer to test astigmatism continued till Javal constructed the most perfect form of this instrument. In Javal's optometer (fig. 2), presented in 1865, a convex lens was placed in the ocular and the radius figure moved away until but one line was most distinct. Concave cylinders were then introduced at right angles to this axis till all parts of the figure became about equally clear. Javal introduced a numbering of cylinder axes that has since become standard, that is, from left to right,

0 to 180. The monocular findings were finally checked binocularly. With this optometer he secured the first successful correction of his own astigmatism and demonstrated also the astigmatism that occurs after extraction of cataract.

The elder John Green, then in Snellen's clinic, realized that consciousness of the close proximity of the object prevented the accommodation from completely relaxing. He adapted Javal's method for use at 20 feet (6 meters), thus initiating the present procedure, by substituting for the optometer diagram a large chart with sixty radiating lines at intervals of 10 degrees.[1] The space-saving "astigmatic fan" of Snellen, published in 1875, is but the upper half of Green's chart. Holth [2] incorrectly credited Javal with the invention of the radius figure, but Burow demonstrated an optometer with a similar diagram in 1863. Burow borrowed the stelliform figure from Donders (1860), and Donders from Helmholtz. The familiar clock dial, however, was Javal's own innovation.

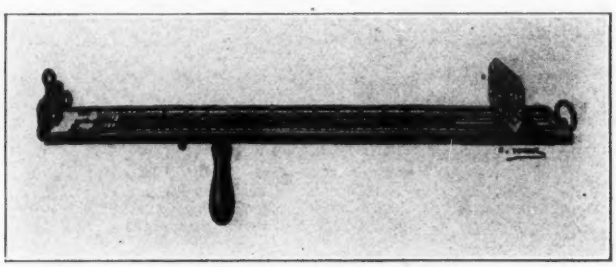


Fig. 2.—Javal's optometer.

The clinical ophthalmometer of Javal and Schiötz was hailed in its day as the greatest contribution to ophthalmology since the ophthalmoscope. A preliminary advance was made by Coccius, who introduced in the Helmholtz instrument the birefringent crystal (1872). Javal's ideal of further simplicity and precision was realized after four years of patient labor. With his perfected instrument he completed more ophthalmometric measurements in one day than had been accomplished by all observers with the Helmholtz apparatus in the previous twenty-five years.

The earliest reports of astigmatism, in which the observers cited their own defects, were considered curiosities. Even in 1854, Isaac Hays, of Philadelphia, published as noteworthy reports of 3 cases of

1. Green, J.: On the Detection and Measurement of Astigmatism, Am. J. M. Sc. **53**:117, 1867.

2. Holth, S.: The First Radius-Figure for Subjective Astigmometry, Brit. J. Ophth. **20**:415, 1936.

astigmatism in which correction was obtained with cylinders. The prevalence of astigmatism, first suspected by Goulier (1852), was firmly established by Donders (1862). Donders regarded the common errors of low degree as within normal tolerance, but Javal insisted that the relief of visual fatigue required even their meticulous correction. By continually emphasizing that the normal eye does not readily tire, he promoted better refraction and overcame the previous hesitancy in prescribing cylinders. Since a dilated pupil exaggerates the defects of astigmatism, he advised testing in reduced illumination. Not having the advantages of a cross cylinder, he resolved doubts as to the exact axis by tilting the patient's head alternately to the right and left; if the vision seemed improved with the head tilted to the right shoulder, a shift of the cylinder to the right was indicated.

ORTHOPTICS

Javal's younger sister, who is still living in Paris, has the distinction of being the first person in the world to receive orthoptic training. Sichel, who saw her at age 2 years, prescribed alternate occlusion. When she was 10, Javal started his experimentation, Giraud-Teulon having tried prisms without avail, but after six years he was only partially successful. When the sister was 16 von Graefe performed tenotomy, which likewise failed to correct the condition fully, whereupon Javal resumed his methods and achieved a perfect cure, which has persisted to this day.

Javal revived Buffon's view that squint was an anomaly of binocular vision and rejected the current idea that the ocular muscles were primarily at fault. He began with the hope that the orthoptic attack would eliminate any need of surgical intervention, but finally concluded that a better management of squint was assured by a partnership of operative aid and functional education. With the courage of his convictions, he had de Wecker perform tenotomy on his 16 month old nephew. The child then wore a shield constantly on one eye or the other for the next seven years. Stereoscopic exercises were started at the age of 9 and continued for three and one-half years, with the ultimate reward of a normal appearance and stereoscopic binocular vision.

In Javal's system, explained in his "Manuel du strabisme" (1896), the successive objectives were to overcome suppression, to train fusion and to establish the correct relation between accommodation and convergence. For children under 6, Javal restricted his treatment to accurate refraction and to promote normal projection, he kept one eye or the other constantly occluded. The use of the shield was not entirely abandoned until after adequate binocular training. Between the ages of 8

and 10, when the child's attention and obedience were at their best, was his preferred period for stereoscopic exercise. After he had taught binocular vision with his hinged stereoscope, fusion amplitude was trained by narrowing the angle of the mirrors. Shifting then to the lenticular stereoscope, he began with large letters and words, gradually decreasing to those of smaller size. The lenticular stereoscope, consisting of 10 diopter lenses, was capable of three major variations, in the distance between the lenses, in the distance between the centers of the cards and in the distance between the card and the lenses, so that with proper manipulation accommodation could be stimulated without convergence and vice versa. Exercises were provided for home training with the simplified stereoscope popularized by Oliver Wendell Holmes. As a further help for primary convergence excess, bifocal lenses were advised. The final training of the patient was in bar reading of ordinary type.

Javal's procedure was derived from an investigation of 440 private patients. Not all required prolonged attention; several with secondary divergent squint after operation were cured in from four to ten days. The results obtained with certain patients, for instance, a niece, were not considered worth the time and effort required. Though Javal developed orthoptic training, Hirschberg [3] discovered that to Dubois-Réymond belongs the first suggestion of using the stereoscope in this field (1852). Hirschberg also took exception to Javal's introduction of the term amblyopia ex anopsia, for which he would substitute as etymologically more correct amblyopia ex ablepsia.

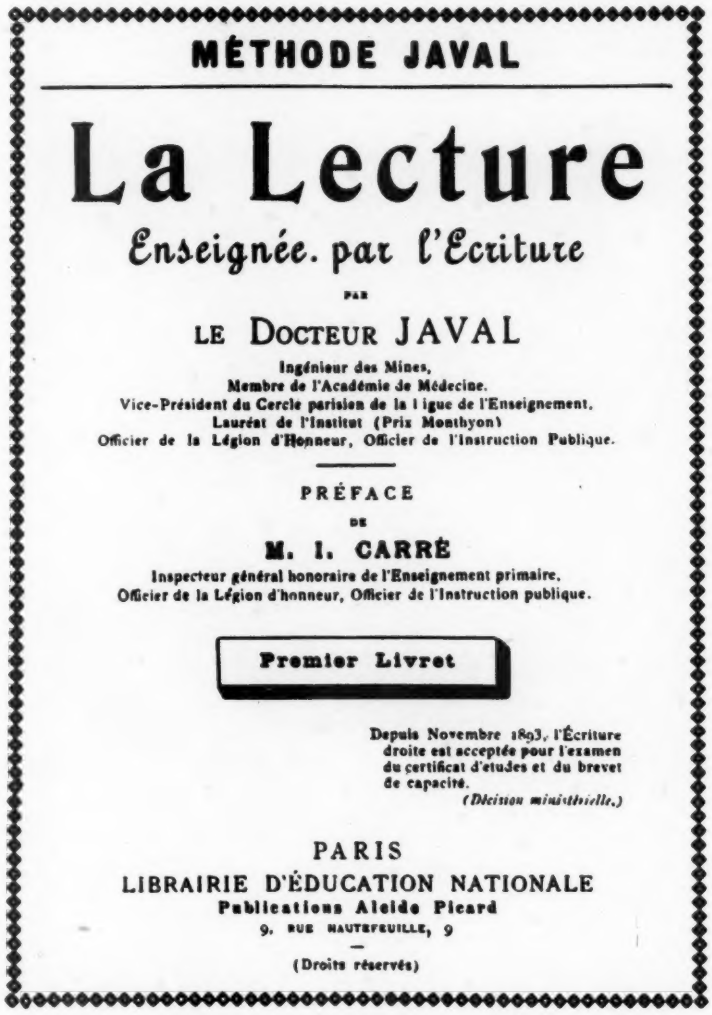
VISUAL HYGIENE

Javal's discovery of the character of ocular movements in reading in 1879 was a by-product of his research in orthoptics. To detect when eyes were used binocularly or alternately, he asked his student Lamare to watch their action behind a glass plate on which horizontal strips of print had been pasted. The saccadic movements then revealed laid the basis of an objective analysis of reading ability that has since culminated in instruments for recording ocular movements and for training efficient reading habits.

In 1885 Javal proposed an original method for teaching reading and writing simultaneously and, with the collaboration of two of his daughters, prepared illustrative textbooks (fig. 3). To accelerate learning, he introduced letters in their order of frequency. With "a-b-c-d" no phrase

3. Hirschberg, J., in von Graefe, A., and Saemisch, T.: Handbuch der gesamten Augenheilkunde, ed. 2, Berlin, Julius Springer, 1918, vol. 15, pt. 2, p. 536.

formation is possible, but with "r-a-l-i" the child could write "Lili a ri," and "Lila rira" in the third lesson. By the thirteenth lesson, he was reading and writing stories even though he knew but half the alphabet.


MÉTHODE JAVAL

La Lecture

Enseignée par l'Écriture

PAR

LE DOCTEUR JAVAL

Ingénieur des Mines,
Membre de l'Académie de Médecine,
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Lauréat de l'Institut (Prix Monthyon)
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PRÉFACE

DE

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Depuis Novembre 1893, l'Écriture droite est acceptée pour l'examen du certificat d'études et du brevet de capacité.
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Fig. 3.—Javal's reading primer.

Javal emphasized hygienic school construction, proper posture and efficient writing habits. With many educators of that period, he favored vertical penmanship, a beautiful example of which is the hand of Thomas A. Edison. His studies of the effect of variations of light, paper and print on the ease and speed of reading foreshadowed the modern interest in the subject. Considering the problems of typographic

legibility, he sought with the aid of his assistant Sulzer to determine the most readable type in feeble light. In his analysis of typography he surveyed all writing symbols from cuneiform inscriptions to musical notation. He suggested that the change of pens from quill to steel caused the handwriting to alter from Gothic to angular. Ever motivated by humanitarian ideals, he stressed that to facilitate reading and writing is to accelerate communication among men.

BLINDNESS

Unfortunately for Javal, the modern operations for glaucoma simplex, as exemplified by sclerectomy, trephining, cyclodialysis and iridencleisis, were introduced after his eyesight had been destroyed by the disease and ineffective intervention. In 1883 the first premonitory attack affected the right eye, and the election campaign of 1885 provoked a severe exacerbation. In August of that year the left eye also began seeing halos and was kept for the next fifteen years constantly under the influence of pilocarpine. Noyes, who chanced to examine Javel in 1885, observed a deep excavation of the right disk and advised operation. Sclerotomy performed on November 10 and on December 3 of that year failed to control the tension, and iridectomy performed on December 11 proved disastrous; the vision, which had been 20/20, was lost completely.

After finishing his term as deputy in 1889, Javal devoted himself wholly to scientific interests. In 1890, at the banquet of the International Congress of Ophthalmology at Berlin, where he was seated with Jonathan Hutchinson and other distinguished guests, his fervent response to Hirschberg's address of welcome ended in a spell of obscuration. Hirschberg then noted in the left eye an excavated disk with a spontaneous arterial pulse. Javal, however, continuing with his work, in 1891 edited his "Mémoires d'ophtalmométrie" and in 1896 released his "Manuel du strabisme," which epitomized thirty-three years of experience and observation.

In 1897 the excitement of the Dreyfus trial at Rennes precipitated an attack in his only seeing eye that left him blind for some hours. Now keenly aware of his prospective doom, he prepared his notes for easy accessibility so that whatever happened he could carry on his appointed tasks. The light sense progressively diminished, until finally red looked like black. In February 1900 he journeyed to Birmingham, where Priestley Smith performed a futile iridectomy, using cocaine hydrochloride anesthesia; in five months Javal was sightless. Later in Paris the cervical portion of the sympathetic trunk was denuded, but without benefit. Command of the laboratory was transferred to the able leadership of Tscherning, and Javal became honorary director.

Stark blind at 62, Javal resolved to imitate those brave souls like Euler, Huber, Milton and Fawcett, who had not been deterred by a like fate from magnificent achievement in such diverse fields as physical and natural science, literature and public affairs. In 1901 he invented a writing rack and published in vivid detail his auto-observations on glaucoma. In 1903 came his most widely circulated volume, "Entre aveugles," translated into German by Turkheim and into Esperanto by his daughter-in-law and available to English readers in two versions, "The Blind Man's World," by Ernest Thompson, of England, and "On Becoming Blind," by Miss Carroll Edson, of the United States. To

Fig. 4.—The blind Javal taking his exercise on tandem bicycle.

Javal, dependence was the chief misery of blindness, and he aspired in his book to help the blind to help themselves. He advised paid help, when possible, as preferable to voluntary attendance. He encouraged physical as well as intellectual activity, and by means of a tandem bicycle he continued regularly his favorite exercise (fig. 4).

About this time Javal became a passionate Esperanto enthusiast and financially supported a central bureau in Paris for its advancement. He pleaded for the general adoption of this auxiliary language, which would be of especial advantage to the blind, since it would permit an international use of Braille publications. To his friend Zamenhof, a Warsaw oculist who invented the language, he made various acceptable

suggestions to render Esperanto even simpler. To Zamenhof was dedicated his following work, the comprehensive "Physiologie de la lecture et de l'écriture" the first edition of which, published in 1905, was exhausted in three months.

Javal was working on the second edition of this text when illness intervened. The invitation of the Ophthalmological Society of the United Kingdom to give the Bowman Lecture for 1907 had to be declined. Death came on Jan. 20, 1907, from gastric cancer after five weeks of intense suffering. Javal had written Priestley Smith that he would will the eye that had been operated on to him, so that he should not consider the operation a total loss. The promise was kept; after

Fig. 5.—Bibliothèque Javal, at the Clinique ophtalmologique de l'hôtel Dieu.

Javal died, Tscherning enucleated the eye and dispatched the visual organ in preservative to Birmingham. In accordance with Javal's behest, the body was cremated at Père Lachaise with private obsequies. But throughout the civilized world scholarly journals and organizations paid homage to the passing of a personage.

Javal had five children (two sons and three daughters) and twelve grandchildren. Though he was reared in traditional Judaism and never deviated from his formal allegiance, he was devoted to the ideal of universal brotherhood and insisted that the spiritual and ethical education of his children be free from all dogma. His son, Jean, a civil engineer, who succeeded to his place in the national assembly, lost his life in the

World War. His other son, Dr. Adolphe Javal, studied under Widal and with him investigated the purification of water by chlorine. He recently published his experience with military sanitation during the war ("La grande pagaïe," 1914-1918). He never entered private practice and since demobilization has been occupied chiefly with literature and economics.

After Tscherning was called to assume the chair of ophthalmology at the University of Copenhagen in 1909, the laboratory of ophthalmology at the Sorbonne was closed and the space reassigned to the department of physiology. The famous library of Sichel and Javal remained conserved by Professor Dastré till 1914, when at the instance of Javal's widow the library was completed and transported to suitable quarters in the Clinique ophtalmologique de l'hôtel Dieu. A splendid bust of Javal by Verlet was presented to grace the reading room. On Feb. 18, 1914, the bibliothèque Javal was dedicated, a fitting memorial to one of the great scholars of ophthalmology (fig. 5).

Javal's children, Dr. Adolphe Javal and Mlle. Mathilde Javal, gave me access to information, material and portraits not otherwise available.

PSYCHOLOGIC CONSIDERATIONS IN THE STUDY OF BINOCULAR FUNCTION

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The study of binocular function requires a psychologic as well as a clinical understanding of individual responses more than other branches of ophthalmologic investigation. Physicians trained mainly in established clinical methods may neglect this psychologic approach to the study of binocular function and the need for binocular training.

As a prerequisite to this approach, one should know (1) what constitutes an average normal binocular response on a binocular instrument, such as a synoptophore or a calibrated stereoscope; (2) how such readings may be correlated with established clinical methods of examination; (3) in what different ways binocular imbalance may become manifest, and (4) to what extent abnormal responses represent psychologic or functional impairments.

The psychologic elements are interrelated with certain physiologic responses. These are represented by the muscular movements concerned in the changing fixation of the two eyes that follow two targets which move toward or away from each other, as in the stereoscope, namely, the disjunctive movements of the eyes. The psychologic aspect concerns itself with the ability of two eyes, made to work independently by the interposition of a septum (as in a stereoscope), to fuse the corresponding images into a single image.

A clinical study concerns itself with qualitative reactions and also with an actual quantitative measurement of the disjunctive movements of the eyes. It must also consider coexisting psychic fusional registrations.

It is difficult to disassociate the intricate psychologic, innervational, structural, developmental, accommodative and even chemical changes which may take part in the infrequent spontaneous correction of a binocular imbalance. It also cannot be explained satisfactorily how orthoptic training improves binocular status. One can point only to end results, and then speculate vaguely on underlying processes.

Were it possible to think of muscles as elastic bands it would be simple to explain such altered clinical phenomena. Luciani and other physiologists have credited muscle tissue with only slight elastic properties. More recently, certain physiologists, notably Hill [1] (1926) and

Read before the New York Society for Clinical Ophthalmology, Dec. 5, 1938.

1. Hill, A. V.: The Viscous Elastic Properties of Smooth Muscle, Proc. Roy. Soc., London, s.B **100**:108, 1926.

Levin and Wyman[2] (1927), have suggested that the mechanics of muscular contractions are governed by viscosity as well as by elasticity. In a mathematical and experimental treatment of the subject they showed that the facts can be accounted for on the assumption that the muscle is a complex system consisting of a free elastic part, comparable to an undamped spring, and a viscous elastic part, comparable to a highly damped spring. However interesting such isolated experiments may be, they clarify in but a small way the complex phenomena participating in ocular muscle response due to a combination of positive and negative forces subject to peripheral and central nervous control.

Let a muscle response, such as abduction, be considered not simply as a contraction of the lateral rectus muscle but also as a stretching of the medial rectus muscle. (Stretch limit is a physiologic term applied to muscles.) With such an inclusive conception, one strives, say in a case of convergent squint, to increase the elastic abduction response; in other words, figuratively to stretch the internal rectus muscle as if it were an elastic band.

Resiliency or recoil in an elastic body, such as a spring, is governed by the degree to which it is stretched. When a spring has been stretched by a load, it recovers its original length and elasticity after the removal of the load, provided the stress by the load does not exceed a certain threshold value. This value is called the elastic limit. With stresses beyond the elastic limit, the power to recover the original durable form or size, namely, the elastic property, becomes less. The recovery point of the stretched or lengthened substance approaches more and more the elastic limit. In the case of binocular response, the elastic limit would correspond to the "breaking point," or limit of muscle duction, and the "recovery point" would represent the status quo, or position of rest from which such stretching or ductions could again be resumed. In a case of squint it is important not only to raise the duction, or "breaking point," of the excessively strong muscles but to diminish their relative elasticity, namely, to raise the "recovery point" to approximate the "breaking point."

A binocular study on a synoptophore or a calibrated stereoscope[3] should include:

1. Measurement of the angle of squint
   (*a*) Objectively, by observing the corneal reflections of lighted targets brought in line with the angle of squint

2. Levin, A., and Wyman, J.: The Viscous Elastic Properties of Muscle, Proc. Roy. Soc., London, s.B **101**:218, 1927.

3. Krimsky, E.: The Stereoscope in Theory and Practice; Also a New Precision Type Stereoscope, Brit. J. Ophth. **21**:161 (April) 1937; Some Newer Developments in Precision Type Stereoscopes, Arch. Ophth. **19**:394 (March) 1938; Descriptive Atlas of Orthoptic Slides, Tr. Am. Acad. Ophth., 1938, to be published.

(*b*) Subjectively, by observing whether the patient has: True projection or target correspondence at the angle of squint
False projection (abnormal retinal correspondence)

2. Measurement of stereoscopic esophoria, exophoria or vertical phoria for infinity equivalent or selective accommodational ranges
3. Measurement of fusion amplitude for far and for near vision
   (*a*) Abduction range—breaking point and recovery point
   (*b*) Adduction range—breaking point and recovery point
4. Measurement of vertical ductions
5. Determination as to whether stereopsis or third degree fusion exists and to what degree
6. Determination as to whether there is macular or paramacular suppression

This will enable one to classify a case of binocular imbalance as to: (1) convergence excess (esophoria or esotropia for near vision), (2) convergence insufficiency (exophoria or exotropia for near vision), (3) divergence excess (exophoria or exotropia for far vision) and (4) divergence insufficiency (esophoria or esotropia for far vision). It will also enable one to adjust the binocular training instrument to such particular type of dysfunction.

The principles governing the operation of a binocular instrument conform to simple and well recognized ophthalmologic methods.

From a psychologic standpoint, the following problems are considered: (1) the meaning of fusion; (2) duction readings in relation to psychologic influences; (3) the meaning of stereoscopic pictures; (4) the requisites of a binocular instrument, or a critical analysis of methods used in binocular study and training; (5) what to expect from orthoptic training; (6) the role of technician or orthoptist, and (7) orthoptic training as a problem for the ophthalmologist, or a comprehensive plan for closer cooperation between clinician and psychologist.

THE MEANING OF FUSION

The subject of fusion will, for the sake of brevity, be dismissed with but a definition of the term.

Fusion consists in the blending of two like or somewhat dissimilar (stereoscopic) pictures into a single image. It also indicates the ability of the eyes to superimpose two entirely dissimilar images. The mere act of fusion does not, in itself, necessarily indicate that the binocular status is normal. It merely shows that there has been a psychologic blending of two images. A quantitative study of fusion consists in the measurement of phoria, the fusion amplitude, the ability to fuse stereoscopic pictures, etc. It is only after these and other findings are recorded accurately that one may evaluate the fusion status.

DUCTION READINGS IN RELATION TO PSYCHOLOGIC INFLUENCES

There are numerous psychologic elements which no doubt play an appreciable role in varying the amount of fusional or duction response. Some of them are considered here.

(*a*) Worry, time of day and illness lead to a state of fatigue. A lengthy examination also is conducive to fatigue and to lack of attention. For this reason it is sometimes wise to make recommendations on the basis of repeated examinations rather than on a single study, no matter what method one employs.

(*b*) Concentration is an important factor in modifying duction readings. Psychologic influences appear to exert a much greater effect over disjunctive movements, such as adduction and abduction, than over conjugate movements. Even in such a simple clinical test as measuring the convergence near point, one must seek the patient's willing cooperation. The psychologic approach of the examiner is always a factor which may alter the readings. Lack of concentration may further be contributed by such elements as fear, noise or lack of privacy.

(*c*) The method of operating a binocular instrument, such as speed of excursion of targets, whether it is operated by the examiner or by the patient, also registers their influences. Furthermore, the types of pictures used in the carriers are of decisive value in winning the child's cooperation and will be dealt with separately.

THE MEANING OF STEREOSCOPIC PICTURES

The ophthalmologist is likely to be a little bewildered with stereoscopic pictures. They often appear meaningless and cannot be correlated with older clinical methods of study. Moreover, they look too complicated for the child, who can profit best from binocular study and training.

From the clinical standpoint one should, first, distinguish fusion from nonfusion slides; second, distinguish simple from difficult fusion slides; third, analyze third dimensional or stereoscopic pictures, and fourth, determine the retinal angles which targets subtend.

From a psychologic standpoint, my objections to many stereoscopic pictures are that they contain too much detail matter, have no major point of interest, are not sufficiently appealing to the young child, i. e., do not have enough human interest, and contain too much descriptive matter.

Even many of the pictures in children's picture books seemed interesting on the surface but were not simple enough for the younger child. A Walt Disney picture would prove uninteresting if it had too many unnecessary lines to distract the attention from a central focus of interest, such as a tree, a house or a path. I found that photographs of

simple toys, or colored drawings with the fewest lines would hold the child's attention. Pleasing pictures simplify the study of binocular function in the child and because of their psychologic appeal will often yield greater duction readings than poorer pictures. As in walking, there is also a psychologic element to ductions; for pleasing pictures serve the same purpose as nice trees and pretty scenery. In one instance the person instinctively makes more effort to increase his duction range; in the other, he enjoys his walk and proceeds farther with less effort.

THE REQUISITES OF A BINOCULAR INSTRUMENT

In order for a binocular instrument to have diagnostic value, it must be a well constructed unit and be so calibrated as to yield quantitative readings of the binocular status of the eyes in its various aspects. Only by careful, and occasionally by repeated, studies can one determine a deficiency in binocular function. Furthermore, without such measured readings of the binocular status one cannot have an intelligent basis for recommending binocular training. This must be adapted to the particular type of disturbance which the patient presents; namely, a binocular instrument must also possess diagnostic merits.

Instruments for orthoptic training present either a rotary or a horizontal type of motion. Conditions amenable to binocular training involve either the medial or the lateral rectus muscle. The problem is to turn the eyes out when they turn in, and in when they turn out. With a binocular instrument the aim is first to induce fusion and then to increase the duction range. Horizontal separation or approximation of targets carries out such a physiologic or psychologic function. I cannot conceive of rotary movements which increase the motility of the eyes in the cardinal directions to adduct or abduct them, as the case may require. Less ocular motility is required with horizontal excursions than with rotary movements. Slow, graded stretching is far more efficacious than a series of rapid rotary motions. The primary aim is to increase disjunctive duction range; rotary movements merely make one eye follow the other without necessarily affecting such duction.

Every binocular instrument presents certain psychologic features which appeal to the doctor or to the patient.

A flasher, for example, may be regarded as a psychologic device. It has some clinical merit in that it often does awaken a suppressing eye to function with its fellow eye. An elaborate automatic flashing unit has no appreciable therapeutic advantages over a simple hand-operated device.

A revolving, or a rotary, device for targets would be a psychologic feature the merits of which would seem to lie more in fancy based on the idea of motion of the eyes rather than on an intricate clinical or theoretic

analysis of the actual benefits of such rotary motion. I have seen no reason to incorporate this feature in a binocular instrument for the correction of squint.

Automatic motion of targets fits in with the present day psychologic concept that comfort and conservation of energy are things to be sought for. I have avoided automatic motion just because it renders such ocular training passive and is therefore conducive to laziness.

A calibrated stereoscope or synoptophore, which the patient can operate, with smooth and mechanical horizontal excursions of targets is the most logical device for binocular training. Such self operation would correspond physiologically to the voluntary movements of the eyes and psychologically would stimulate an active interest in improving binocular function. Normally the eyes do not move steadily from one fixation point to another but in rapid jerky fashion. After each rapid jerk there is a fixation pause, during which they remain relatively at rest. It would seem logical, therefore, that enforced exercises of the eyes should be based on such interrupted ocular movements, and with a hand-operated instrument they could be better controlled to correspond to the physiologic and psychologic peculiarities of the subject's eyes. In piano playing there is also an intimate association between the brain, the eyes and the fingers; in other words, a psychophysical parallelism.

WHAT TO EXPECT FROM ORTHOPTIC TRAINING

The most unfavorable aspect of orthoptics is that it has been unfairly exploited as a cure for cross eyes, without critical analysis of the binocular status of the eyes. Even the word orthoptics is faulty in that it creates suspicion in those who prefer to think primarily of binocular status rather than of binocular training. That term would imply that straightening of the eyes is the primary aim. As a matter of fact, what one strives for in orthoptics is, first, a functional result and, second, a cosmetic result. I object to the word orthoptics because it suggests impressive methods that will put the eyes in motion without critical reflection as to the fundamental psychologic or physiologic basis for such ocular calisthenics. I would substitute the term controlled binocular training to indicate that responses must be measured in order to have clinical value, whereas mere exercises have suggestive or autosuggestive value.

THE ROLE OF THE TECHNICIAN OR ORTHOPTIST

Orthoptics has created in the mind of the ophthalmologist the fixed idea that it cannot be practiced satisfactorily without the aid of a trained technician. I do not concur in this idea. My plan has been to examine the child with a major instrument in the office and then to explain to the intelligent mother or relative in simple terms what is being attempted in

order to correct a binocular dysfunction, and thereby to gain her cooperation as an intermediary in observing the child's training on a junior calibrated instrument at home under my periodic supervision, provided the eyes show true retinal correspondence. Children showing abnormal retinal correspondence are not suited to home training until such correction has been made in office or clinic. Fortunately, such patients are less common. The child is taught to keep records of progress and, if possible, to operate the instrument himself rather than to have the mother manipulate the targets.

The orthoptist may prove of value as a psychologic assistant to the ophthalmologist in certain selected cases. She may advise the mother as to teaching the child to concentrate on targets, selecting those pictures most suitable for the individual child, training the child to play an active rather than a passive role in stimulating increased ductions and keeping records of progress; she may also suggest to the ophthalmologist the psychologic aspects of the child's case, namely, the intelligence quotient, the child's determination to make headway and ways to improve the psychologic approach. It is far more important for the ophthalmologist to realize the problems of the psychologist than for the latter to study the clinical aspects.

ORTHOPTIC TRAINING AS A PROBLEM FOR THE OPHTHALMOLOGIST

The office or the clinic is not the most practical setting for orthoptic training. Binocular study and binocular training involve the expenditure of valuable time, which interferes with office routine. The use of a binocular training instrument in the office or clinic usually entails the hiring of an assistant to relieve the ophthalmologist. If training is to be recommended at all, it should be done daily rather than once or twice a week, as in the office or clinic. Even though binocular training is definitely helpful in selected cases, the length or duration of such treatment cannot be foretold and must be based on individual responses. And, finally, office or even clinic orthoptics is an expensive process.

The home is the ideal setting both for comfort and for concentration. Most clinics are not conducive to quiet and privacy, and even when such conditions are passable, the patient can return only once or twice a week. If exercises are to be continued for months, this may prove a drawback. Daily exercises at home would probably shorten the duration of such training.

What is one to do with the patient who cannot afford to rent a desirable instrument? I believe that the school system should set aside special periods during which the teacher, usually the kindergarten teacher, may train and interest the child in the operation of a binocular

instrument. I believe that the teacher as an educator thoroughly acquainted with the child as a child can adopt a sympathetic and patient approach which is impossible in the office or clinic. These children should be seen by the ophthalmologist at regular intervals to decide whether training should be continued or stopped or progressively increased. He may cooperate with the teacher through simple written instructions, without her having to be burdened with the clinical study of binocular function. The teacher may thus serve as the natural complement to the ophthalmologist in the psychologic training of binocular dysfunction. There are cardiac classes for school children. These children are regularly observed by physicians interested in that field. It does not necessarily follow that the children's hearts become normal, but they are being watched by competent men in their respective fields. Such allied fields as otolaryngology have found their entrance into the school system through audiometric testing, lip reading and other matters which are of psychologic as well as of medical interest.

I can conceive of the ophthalmologist working hand in hand with the educator, rather than being just a trained refractionist in the school system, as in the present setup.

CONCLUSIONS

1. A clinical study of binocular function should be a prerequisite to a psychologic approach to the problem. This should include a careful qualitative and quantitative instrumental study of the binocular status of the eyes.

2. The principles underlying the operation of a binocular instrument are simple and conform to recognized ophthalmologic theory and practice.

3. Duction readings are subject to psychologic influences, such as lack of concentration, will, nature of targets and environment.

4. The physician who has not mastered the diagnosis and measurement of binocular function is in no position to recommend binocular training.

5. A binocular instrument should provide a balance between psychologic and scientific features. It must provide a satisfactory means for measuring the binocular status of the eyes, otherwise it is unsatisfactory for binocular training.

6. The home would seem to offer a satisfactory environment for controlled binocular training in cases in which eyes show true retinal correspondence.

7. When binocular training is economically prohibitive, daily training should be provided in schools rather than in clinics, with periodic check-ups by a trained ophthalmologist.

8. The role of the orthoptist shall be that of psychologist or educator; the role of the ophthalmologist, that of clinician. Satisfactory binocular training may be supervised by the teacher without an intimate knowledge of binocular function.

DISCUSSION

DR. LEGRAND H. HARDY: Dr. Krimsky has done a great deal of splendid work, particularly in improving the stereoscope, but he has greatly and unjustifiably oversimplified the problem in order to present his point of view. The mechanics and physiology of squint are much more complex than he assumes.

I do not think that one is justified in treating fusion as the simple, although vaguely defined, process postulated by Dr. Krimsky. He has mentioned only one component of the process of fusion. This may be characterized as the cerebral component. Others, possibly as important, are the factors involved in conduction and in the formation of retinal images and, finally, the extraocular factors.

The conduction component offers an anatomic basis for a weak or absent fusion ability. It relates to the degree of decussation at the chiasm. Electroencephalograms may furnish important data for evaluating this factor. The factor concerned in the formation of retinal images involves differences in the sizes of the images and induced size effects, which likewise may have an important bearing on the problem of squint. Finally, the extraocular factors, the proprioceptors of the extraocular muscles, may have an important bearing both on the conception of the squinting process and on the surgical treatment.

Nor are the physiologic factors of stereopsis well understood. Most tests are based on pure disparity of imagery, which produces the illusion of depth. Many other factors enter into this sensation. I have mentioned ten ways of producing the illusion of depth in flat pictures. Few stereoscopic tests are based on actual depth.

Dr. Krimsky's discussion of the importance of the psychologic factors entering into the diagnostic and therapeutic methods used for squinters is excellent. Few ophthalmologists have the temperament, imagination or training for such work.

I disagree most emphatically with Dr. Krimsky's statement that the best place for training is under the supervision of a parent at home. If one limits the discussion to persons with phorias or tropias and well established normal retinal correspondence, this procedure has definite merits, but for 60 per cent or more of persons with tropias and anomalous retinal correspondence Dr. Krimsky's proposed procedure is extremely dangerous and is bound to lead to incalculable harm. No such patient should be given any orthoptic treatment unless it is under the direct supervision of an expert technician; otherwise all efforts will serve only to confirm rather than cure the squint and will make the complications more severe and difficult for the surgeon who finally has to operate. This particular misapplication of orthoptics has been the outstanding stumbling block and has caused the greater part of the discouragement, disappointment and disbelief in the method.

Clinical Notes

A COMBINATION OF THE SNELLEN AND THE LANDOLT TEST TYPES

DAVID D. WAUGH, M.D., BROOKLYN

Since Snellen first presented his test types in 1862, numerous attempts have been made to improve them. His figures subtended an angle of 5 minutes, each element subtending an angle of 1 minute. Oblong letters, 5 minutes in height and 4 in breadth, have been suggested. Easily recognized confusion and difficult letters have been used. Lines, dots and concentric circles have had their trial. The recognition of the capital E has been used, especially for illiterates. In order to exclude the large psychologic factor, Landolt devised the broken circle as a measure of two point separability. This has subsequently been accepted as the international standard for tests of visual acuity. Broken squares of different sizes have also been used.

Time and experience have left only two types for routine office and clinic practice, the Snellen figures and Arabic numerals of a similar size.

A combination of the Snellen and Landolt test types.

It was felt that a combination of the popular Snellen types with the Landolt broken circle would be the next step in the development of the perfect test type. Investigation of the English alphabet revealed the fact that there are ten letters the base of which is a small round circle. For the visual acuity chart, this base is a circle subtending a visual angle of 3 minutes, having a central aperture of 1 minute angle. On the chart this is the letter o. A break across the top subtending a 1 minute angle makes the letter u; a similar break on the right side makes the letter c.

The addition of a 1 minute stem below and to the right of the o forms the letter q. A 1 minute stem below and to the left makes the letter p: above and to the right, the letter d, and above and to the left, the letter b.

The addition of a 1 minute stem below and to the right of the u forms a y.

A stem below and to the left of the c results in an f.

The combination of a break below with a stem above and to the left completes the letter h.

Several other letters might be used, but they would probably be too confusing. The letters are the result of one addition, one subtraction or a combination of one addition and one subtraction of 1 minute breaks and stems on a 3 minute base in the form of the letter o. This would appear to have accomplished the same two point separability as Landolt's broken circle and at the same time to have retained the practicability of the Snellen figures.

No claim is made that this is the perfect test type. I realize that some patients may have difficulty in interpreting the letters, though clearly seen. The dimensions of the component parts have not all been held to 1 minute. Some are 2 minutes, but none is higher. However, at the time this is the only combination of Landolt's and of Snellen's types that appears practicable, and it is submitted as such.

NEW SCISSORS FOR ENUCLEATION

HENRY G. WINCOR, M.D., NEW YORK

In operating for enucleation one is often disappointed at the small section of optic nerve obtained attached to the globe. Occasionally the nerve is cut at its insertion into the globe, so that no portion of the nerve is obtained for laboratory examination.

New scissors for enucleation.

The instrument pictured here was devised to enable one to obtain a good section of optic nerve. The elevation on the anterior blade is approximately 6 mm. When the scissors are inserted inside the capsule funnel and straddle the optic nerve, the act of closing the blades automatically raises the globe and puts the optic nerve on the stretch. Incidentally, the globe is protected from being cut or injured. The nerve is then cut by the lower blade.

The amount of nerve obtained is always equal to the height of the elevation on the upper blade and sometimes more. There should be no difficulty in inserting the scissors behind the globe. Grasping the globe with a forceps and rocking it sideways while inserting the blade will facilitate the introduction of the scissors.

These scissors have been tried out at various times on large eyes, on small atrophic globes, on phthisic globes and on children's eyes. In each instance a large section of nerve was obtained.

Ophthalmologic Reviews

EDITED BY DR. FRANCIS HEED ADLER

OCCUPATIONAL KERATITIDES AND CORNEAL DYSTROPHIES

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NEW YORK

The definition of a subacute or chronic occupational disease as distinguished from an acute industrial injury due to a single accident has been considerably broadened by legislatures. One therefore has to consider other occupational diseases of the eyes in addition to those previously recoghized, namely, miners' nystagmus, glassblowers' cataract and other forms of radiation cataract and cataracts due to systemic poisons. The coverage of occupational diseases is extended not only in relation to the systemic poisons which may indirectly affect vision but in relation to certain substances which may affect the eyes directly, namely, dusts, fumes and oily particles. Those agents affecting the eyes directly may be described as giving rise to occupational keratitides and dystrophies. A clinical and medicolegal review of the subject is therefore presented.

A satisfactory etiologic classification of corneal diseases free from conflicting pathologic and anatomic-topographic criteria and morphologic terms, is as yet not available to the student. Duke-Elder's "Textbook of Ophthalmology"[1] still follows Fuchs'[2] clinical classification of corneal diseases into superficial and deep keratitides and dystrophies. Its artificiality is obvious from the facts that superficial punctate keratitis may be observed secondary to iridocyclitis and a deep involvement in the form of a disciform keratitis may be the end result of superficial herpes corneae. Both authors, moreover, deal with some keratitides under conjunctival diseases because of anatomic and practical considerations. Otchapovsky,[3] in a recent attempt at a classification of the keratitides, introduced a group of true keratoconjunctivitides, characterized by involvement of the limbic barrier, and divided them into nonulcerative chronic forms, with infiltration and vascularization, such

1. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 2.

2. Fuchs, E.: Text-Book of Ophthalmology, ed. 7, Philadelphia, J. B. Lippincott Company, 1923.

3. Otchapovsky, S. V.: De la physiologie pathologique de la cornea, in Kewchariantz, A. G.: Sbornik Dolganova, Leningrad, Académie militaire de médicine RKKA de S. M. Kirov, 1936, p. 341.

as phlyctenulosis, trachoma and vernal catarrh, and ulcerative acute forms, without vascularization or necrosis but with erosions and related to dermatoses, such as herpes, eczema and rosacea keratoconjunctivitides. He therefore questioned the propriety of calling these conditions conjunctivitides. To classify corneal diseases into ectogenous and endogenous forms and those secondary to other diseases of the eye, as suggested by Fuchs and followed by Duke-Elder, is a mere approach to an etiologic classification, but it can hardly be considered as such. The slit lamp has made the classic clinical classification less and less tenable, since it enables one to make a more accurate localization of the depth of lesions and more accurate tracings of the path they take in their evolution.

A virus causation is being increasingly designated as the cause of a large group of corneal diseases. Grüter [4] ascribed a herpetic nature to dendritic, vesicular, bullous, disciform, superficial punctate, alphabet, reticular and interstitial keratitides and to relapsing erosions. Vazquez-Barriere,[5] on the basis of present knowledge, listed the following corneal diseases in the virus group: herpes corneae, herpes zoster ophthalmicus, superficial punctate keratitis, disciform keratitis of Fuchs, the metaherpetic keratitis of Vogt, keratitis nummularis, relapsing erosions and certain forms of deep keratitis. He found them characterized by vesiculation, ulceration, infiltration, lack of anchorage of epithelium to Bowman's membrane, rapid changes in structure, recurrence and hypesthesia. To these one may now add trachoma and some cases of endophthalmitis, according to Friedenwald and McKee.[6] Vitamin starvation is assigned an etiologic role in some keratitides, and allergies and endocrinopathies are increasingly being recognized as factors in others.

Dystrophies are somewhat better classified as senile, hereditary, secondary and occupational. Owing to the use of the slit lamp, occupational keratitides and dystrophies have been more and more frequently reported of late, in lieu of the diagnosis of conjunctivitis due to occupations.

The occupational keratitides as well as several other keratitides are treated by Fuchs [1] under diseases of the conjunctiva, and occupational conjunctivitis is defined as "an acute conjunctivitis found in certain industries where irritants—acrid vapors, liquids, or dustlike particles—get into the eyes either by accident or as part of the day's work." Under conditions allied to corneal dystrophies are further described changes

4. Grüter, W.: Beiträge zum mikroskopischen Bild des Hornhautherpes, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **50**:223, 1934.

5. Vazquez-Barriere, A.: El virus herpetico en patologia ocular, Oftalmología **2**:16, 1936.

6. Friedenwald, J. S., and McKee, C. M.: Agent of Endophthalmitis, Am. J. Ophth. **21**:723 (July) 1938.

produced in the deeper layers of the cornea by the continuous action of various substances, such as lime, lead, silver, nitronaphthalin and iron (siderosis). Occupational keratitides are considered by Duke-Elder both under the conjunctivitides and under the keratitides. Under conjunctival diseases and allergies an extensive list of injurious substances is given, and a complete bibliography brings the subject up to date. The subject is further dealt with in Duke-Elder's text under superficial punctate keratitis, which is defined not as a disease entity but as a name embracing a large number of diseases. Under dystrophies further reference is made to electric ophthalmia and to traumatic band-shaped keratitis from mercury fumes and among hatters. There is a strikingly frequent reference to occupational injury or disease as an etiologic factor in the literature dealing with band-shaped keratitis.

The term superficial punctate keratitis, which Fuchs applied to a condition affecting the subepithelial layers only, is today applied with less rigor. Since the introduction of the slit lamp, it is being applied to lesions affecting the epithelial layer as well. Vogt [7] expressed the belief that the polymorphism of the epithelial keratitides is too great to permit a systematic classification and described a "keratitis epithelialis vesiculosa disseminata," a "keratitis epithelialis diffusa" and a "keratitis epithelialis marmorata." Duke-Elder [1] included some of the herpetic keratitides under superficial punctate keratitides. Thiel [8] described superficial punctate keratitis as a condition encountered in acute conjunctivitis, herpes and electric ophthalmia. While the lesions are not often mixed epithelial and subepithelial lesions, superficial punctate keratitis is a preferable term for the occupational keratitides, which embrace epithelial as well as subepithelial varieties.

OCCUPATIONAL SUPERFICIAL PUNCTATE KERATITIS

Occupational superficial punctate keratitis is not a serious condition per se. Except for the acute exacerbations and intermittent blurring of vision, visual acuity is rarely perceptibly affected. It, therefore, does not present a problem in workmen's compensation and is primarily of concern to the industrial hygienist and physician, because it presents a locus minoris resistentiae, influencing the effects of foreign bodies and erosions, their treatment and infections. The diagnosis of subacute or chronic conjunctivitis, a necessarily concomitant condition of superficial punctate keratitis and its exacerbations, should therefore be made by the plant physician with due consideration of a possible occupational factor. A keratitis is obviously a more serious condition for a worker to carry than a subacute or chronic conjunctivitis.

7. Vogt, A.: Atlas der Spaltlampenmikroscopie, ed. 2, Berlin, Julius Springer, 1931, vol. 1.

8. Thiel, R.: Atlas der Augenkrankheiten, Leipzig, Georg Thieme, 1937.

The symptoms of superficial punctate keratitis, without the use of the slit lamp, may give rise to the diagnosis of acute, subacute or chronic conjunctivitis. Vogt [7] described the symptoms found in the epithelial keratitides in general as photophobia, blurring of vision, particularly after the eyes have been kept open for long periods and have become dry, and sometimes pain. Pick,[9] who dealt with an epidemic involving almost 50 per cent of the workers in a mushroom canning factory, listed the symptoms as photophobia, stabbing pain and blurring of vision, especially in the evening. Klein [10] reported severe blepharospasm and lacrimation among workers in the rayon industry. Rankine,[11] who reported 1,598 cases of superficial punctate keratitis observed in two years among workers in the acid house in the rayon industry, listed the symptoms as blurred vision and halos, grittiness, photophobia, lacrimation, blepharospasm, aching back of the eyes and headaches. Bücklers,[12] who reported a series of cases of superficial punctate keratitis in workers with lacquers in the furniture and metal industries, referred to similar observations among workers in the straw hat industry. He described the symptoms as lacrimation, grittiness and burning and stabbing pains, with an increase toward the end of the day and working week and most marked symptoms during the winter months when the ventilation of workrooms is poorest. According to McDonald,[13] "the workers in the spinning room complain frequently of misty vision, halos about lights, pain in the eyeball and tearing. . . . The symptoms are much more acute, but fleeting (as compared with CS_2 [carbon disulfide]) and are usually confined to those working in the spinning, washing and reeling rooms, where some 20 per cent of the workers claimed losing some time from work because of 'sore eyes.'" Powell [14] described a uniocular conjunctivitis from peat dust, observed in 105 agricultural workers on reclaimed marsh lands in California, the symptoms consisting of profuse lacrimation, intense pain and photophobia. Anneberg [15] reported a keratitis from exposure to pigweed and redroot and

9. Pick, L.: Augen- und Schleimhauterkrankungen durch Morchelausdünstungen, Ztschr. f. Augenh. **61**:325 (April) 1927.

10. Klein, E.: Les lésions oculaires dans les fabriques de soie artificielle, Arch. d'opht. **45**:686 (Nov.) 1928.

11. Rankine, D.: Artificial Silk Keratitis, Brit. M. J. **2**:6 (July 4) 1936.

12. Bücklers, M.: Tröpfchenförmige Niederschläge auf der Hornhautoberfläche bei Möbelarbeitern, Klin. Monatsbl. f. Augenh. **99**:676 (Nov.) 1937.

13. McDonald, R.: Ophthalmological Aspects, in Survey of Carbon Disulphide and Hydrogen Sulphide Hazards in the Viscose Rayon Industry, Bulletin 46, Occupational Disease Prevention Division, Commonwealth of Pennsylvania, Department of Labor and Industry, 1938, p. 38.

14. Powell, B. J., Jr.: Uniocular Conjunctivitis from Peat Dust, Am. J. Ophth. **17**:206 (March) 1934.

15. Anneberg, A. R.: Corneal Reaction to Weed Pollen, Am. J. Ophth. **21**: 1265 (Nov.) 1938.

to other weeds among agricultural workers, with symptoms of itching, pain and foreign body sensation. All writers stress evidence of individual predisposition in the form of frequent recurrences in some persons and immunity of other neighboring workers. Thiel [16] also reported having frequently found keratitis punctata superficialis a problem in the sugar and rayon industries. The symptomatology is, therefore, rather uniform.

There is equal unanimity as to the biomicroscopic findings. Vogt [7] described the lesions as closely packed grayish points, commas or lines, from 0.1 to 0.02 mm. in size and even smaller, and seen only after staining with fluorescein; he also stated that they are sometimes seen as confluent lesions in the form of drops without infiltrates or vascularization. According to Pick,[9] the lesions do not stain during the acute stage of onset but later are demonstrable by staining as irregular points, lines and confluent lesions. Klein's [10] description of the biomicroscopic picture included chemosis, conjunctival hemorrhages, corneal edema, infiltrates and later erosions and sometimes confluent lesions. Rankine [11] found edema or irregular swelling of the corneal epithelium and desquamation of the epithelium, with a staining reaction to fluorescein. Bücklers [12] described the lesions as grayish transparent drops, about 0.04 mm. in diameter, staining only occasionally and visible only on transillumination but not directly with the slit lamp. Thiel [8] described the lesions of superficial punctate keratitis as minute gray, discrete and confluent lesions within and beneath the epithelium. Powell's [14] article does not include a description of the biomicroscopic corneal findings, and corneal lesions are not established but are not excluded. Gutmann [17] reported stippling of the cornea and infiltrates among workers in the rayon industry. Rochat [18] reported erosions which stained with fluorescein among workers in the sugar industry. Thiel [8] reported erosions and vesicles also among workers in the sugar industry. McDonald [13] reported fine blisters in the epithelium in the acute stage. The slit lamp picture is, therefore, also rather uniform and is illustrated by drawings in many of the papers cited; it also agrees with that observed by me. Anneberg [15] found conjunctival hyperemia, miosis and large corneal subepithelial infiltrates with no staining reaction to fluorescein. Among other findings, Rankine mentioned a garlic breath, and McDonald, loss of the "corneal" reflex in 50 per cent of his cases among workers in the rayon industry. However, he stated that he was not sure whether to attribute the symptom to exposure to hydrogen

16. Thiel, R.: Keratitis traumatica als Betriebsunfall in Zuckerfabriken, Klin. Monatsbl. f. Augenh. **81**:835 (Dec.) 1928.

17. Gutmann, A.: Augenentzündungen bei Kunstseidefabrikarbeitern, abstracted, Klin. Monatsbl. f. Augenh. **81**:727 (Nov.) 1928.

18. Rochat, G. F.: Schädigung der Hornhaut durch Schwefelwasserstoff, Klin. Monatsbl. f. Augenh. **70**:152, 1923.

sulfide or to intoxication from carbon disulfide, to which the workers are also exposed. It is interesting that Gundersen [19] reported not having observed any vesicles in the herpetic corneal diseases he studied.

For the demonstration of lesions of superficial punctate keratitis, I prefer a 2 per cent solution of mercurochrome, which is less diffusible than fluorescein and provides a better contrast between the lesion and the surrounding area, and slit lamp examination by transillumination from the iris with the microscope focused on the cornea. While the normal cornea shows no epithelial desquamation, the normal conjunctiva appears to be continuously desquamating when stained with mercurochrome, particularly the exposed and lower bulbar conjunctiva. Because of its rapidity, this method should be superior to either corneal esthesiometry or "corneal" reflex testing for mass examination of workers in a plant.

The outstanding offending agents appear to be hydrogen sulfide, principally in the rayon and sugar industries, and benzene and similar solvents and diluents of varnishes and shellacs and lacquers. Likhtner [20] reported on the superficial punctate keratitis observed in persons employed in the cracking process of coal rich in sulfur; he considered a concentration of 1:1,000,000 of hydrogen sulfide as the limit of permissibility. Pick [9] mentioned drops of helvellic acid as an offending agent. Both Klein [10] and Bücklers [12] referred to drops of chemicals on the cornea, and the drops scattered by spinning and spraying rather than the gases involved in the industrial processes are stressed as the factor. According to McDonald, hydrogen sulfide droplets of the acid bath are responsible for keratitis among workers in the rayon industry; he found the condition more marked in damp weather and stated that a concentration of 10:1,000,000 is permissible. Thiel [16] also arrived at the conclusion that hydrogen sulfide is responsible for the keratitis, but he considered the possibility of its conversion into an organic sulfur compound before becoming toxic or of the keratitis being secondary to a dystrophic corneal process caused by the exposure. In Powell's report,[14] however, silica spicules and acids salts are mentioned. Other of the more important agents considered in textbooks and in the literature are hydrogen fluoride, tar pitch, mercury and silver sublimate, certain kinds of woods and lead nitrate. Duke-Elder's [1] list includes many chemicals and animal and vegetable dusts and allergens, such as atropine and pontocaine. This variety of occupational superficial punctate keratitis may be designated as the subacute variety, although some writers consider it acute because of exacerbations. The patients all get

19. Gundersen, T.: Herpes Corneae, with Special Reference to Its Treatment with a Strong Solution of Iodine, Arch. Ophth. **15**:225 (Feb.) 1936.

20. Likhtner, V. A.: Eye Injuries Due to Hydrogen Sulfide in a Petroleum Refining Plant, Vestnik oftal. **11**:256, 1937.

well with change of occupation, and there is restitutio ad integrum in from seven to ten days.

At the New York State Bureau of Workmen's Compensation I have observed only a few cases of the acute and subacute variety, caused by liquid drops in the air clinging to the cornea; the scarcity of such cases is probably due to the vigorously enforced safety measures and the transient nature of the condition as well as to the tendency on the part of the worker to invoke a single accident rather than an occupational disease, owing to the past limitations of the definition of occupational disease. The cases (except 1 in 1937) observed in the last six months occurred in the following persons: a shellac bleacher, a mixture of chlorine gas and sodium hydroxide being the contributing factor; a chemist, fumes of allyl alcohol and formic acid being the agent; a nickel polisher; a sugar crusher, raw sugar dust being the contributing factor; a leather worker, formaldehyde from leather shavings being the exciting agent, with a possibility of trachoma complicating the picture; and a brass filer with a pseudomembranous conjunctivitis and subconjunctival foreign bodies. The last-mentioned patient is still being studied.

SYMPTOMLESS OCCUPATIONAL SUPERFICIAL PUNCTATE KERATITIS

A symptomless form of superficial punctate keratitis which verges on a dystrophy was first reported by Samoilov [21] among lathe workers. That the superficial punctate keratitides of the herpetic group are followed by hypesthesia and even by hypotension is, of course, familiar. Gifford [22] reported on a mild form of epithelial dystrophy of the cornea, thought to be mainly senile, with hypesthesia. In his study of lathe workers, who presented an incidence of corneal scarring of 20 per cent, Samoilov reported a definite corneal hypesthesia amounting to 92 per cent, established by esthesiometric examination with von Frey hairs. Intravital staining with methylene blue showed not only epithelial erosions but disappearance of the normal end organs of the corneal nerve, which Samoilov stated can be abundantly seen in normal eyes by this method. The destruction of the end organs of the corneal nerve he regarded as evidence of a process reaching the subepithelial region. The corneas also showed a greater rate of desiccation than normal eyes. The condition was symptomless, except for pericorneal injection on manipulation of the lids over the eyes. Samoilov attributed the condition to constant bombardment of the corneas by sharp spicules of metal.

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21. Samoilov, A.: Professionalnaia patologia glaza, Obuch Institute for the Study of Occupational Diseases, Moscow, Izdatelstvo Mozdravotdiela, 1929.

22. Gifford, S. R.: The Mild Form of Epithelial Dystrophy of the Cornea, Arch. Ophth. **7**:18 (Jan.) 1932.

Almost every stonecutter, grinder or sandblaster with an accidental injury appearing for ocular examination at the New York State Bureau of Workmen's Compensation has shown numerous bilateral, minute, irregularly shaped and sharp-cornered scars, diffusely scattered throughout the cornea, and often still more minute glistening foreign bodies embedded in the scars. There are no complaints by the claimants other than those referable to the accident and the eye involved. Many of them also exhibit a generally bilateral but sometimes unilateral corneal hypesthesia and minute epithelial erosions; neither type, however, has had any definite relation to the number of scars. Since this condition was not legally an occupational disease and was moreover only rarely accompanied by any appreciable loss of visual acuity and was not compensable until recently, no particular record was kept of the cases except to call attention to the existence of the condition and the possible parallelism with pulmonary silicosis.[23] There are, moreover, few stonecutters in the city of New York, and only about a dozen may be seen at the bureau in the course of a year. The three stonecutters and one grinder encountered in the last six months all had vision of 20/20 and minor ocular injuries, with no complaint except that referable to the eye involved. The stonecutters had worked thirty-four, forty and forty-five years, respectively, at their trade and the grinder, fourteen years; it is probable that younger workers are not affected. All showed scars, hypesthesia and erosions except one, who had scars only.

The influence of an occupational corneal dystrophy on the evolution and development of disciform keratitis, generally characterized by vascularization from the intrascleral plexus by a single vessel, is illustrated by the case of a stonecutter observed at the bureau. This claimant has been a stonecutter for ten years, then a policeman for twenty-five years, and then a stonecutter again for four years. An apparently insignificant foreign body for which he did not seek attention for four days gave rise to a deep ulcer by that time, followed by hypertension, which necessitated paracentesis, and a disciform keratitis as a sequel. The presence of "stonecutters' cornea" in the fellow eye and complete anesthesia make for the probability that the bilateral corneal dystrophy was the result of the original ten years' exposure rather than the exposure of the last four years under modern safety conditions, thus justifying the application of the term dystrophy to the condition.

OCCUPATIONAL DYSTROPHIES

True occupational dystrophies, such as are reported in textbooks and in the literature, have not been observed. In cases of argyrosis

23. Davidson, M.: Silicosis Corneae, Am. J. Ophth. **19**:896 (Oct.) 1936.

Stein,[24] Subal [25] and Blind [26] reported grayish deep opacities and a network of grayish yellow lines in Descemet's membrane. Harrison [27] described a primary zonular opacity of the cornea in a hatter due to mercury fumes.

Zonular, or ribbon-shaped or band-shaped, opacity or calcareous band of cornea was described by Fuchs [2] as the most frequent of the pathologic type of dystrophies, developing because of intraocular disease, in senile persons or because of external injurious influences to which corneas have been subjected in the region of the palpebral fissures.

Michail [28] expressed the belief that an angioneuritis, a sympathicotonia of the surface vessels or a dilatation of subepithelial vessels of conjunctiva is the cause of calcium deposition and of band-shaped keratitis. Comberg [29] explained the site and development of band-shaped keratitis and relapsing erosions by a tendency of epithelial regeneration to start simultaneously from above and below and to result in an overgrowth at or near the meeting point with the horizontal meridian.

Cases of dystrophies sequels of accidents are, however, encountered. Three patients with lime burns of long standing were seen during the past year. Examination proved that a degenerative process goes on in the cornea with lime incrustation in the course of years. One patient was examined at the New York State Bureau of Workmen's Compensation in connection with a lime burn of the left eye. There was a history of a lime burn in the right eye some twenty years before; the eye showed, aside from a lime incrustation in the upper corneal region, a band-shaped lime incrustation in the lower corneal region with typical etched subepithelial lines and numerous chalky white calculi lying at different levels in the corneal stroma as far back as Descemet's membrane, where they were star shaped and lying in round clearings in a homogeneously somewhat opaque membrane. In another patient the same transport of lime had progressed to deposit calculi to about the middle of the cornea in the course of two years. In the third this was observed beginning within six months after a lime burn. In addition, superficial punctate keratitis has been observed by staining and by bio-

24. Stein, R.: Berufsargyrosis der Hornhaut, Klin. Monatsbl. f. Augenh. **81**: 731 (Nov.) 1928.

25. Subal: Berufschädigungen der Bindehaut und Hornhaut durch Silber, Klin. Monatsbl. f. Augenh. **68**:647 (April-May) 1922.

26. Blind: Ein Fall von Gewerbeargyrosis des Auges, Klin. Monatsbl. f. Augenh. **76**:884 (June) 1925.

27. Harrison, W. J.: Primary Zonular Opacity of the Cornea, Arch. Ophth. **16**:469 (Sept.) 1936.

28. Michail, D.: Dégénérescence calcaire primitive de la cornée, Arch. d'opht. **52**:247 (April) 1935.

29. Comberg, W.: Experimentelles und Klinisches über das Hornhautepithel, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **50**:209, 1934.

microscopic examination in persons with an apparently long cured lime burn who complain of recurring redness of the eye.

Wagenmann [30] credited De Gauvea (1869) and Andreae (1898) with observations of the slow transport of lime as far as Descemet's membrane in cases of lime burns; he also quoted Gühman to the effect that there results in the presence of lime incrustation a double fluid current from the lime deposit and the aqueous, with precipitation of lime salts. Thies [31] called attention to the diffusion of both albumin-dissolving alkalis and albumin-precipitating acids into the aqueous in cases of lime burns, with resulting changes in the iris, lens, ciliary body and vitreous and hypertension. These manifestations may be delayed and present problems in the differential diagnosis between injury and disease.

TRAUMATIC FACTOR IN THE HERPETIC GROUP OF CORNEAL DISEASES

The medicolegal problems involved in the occupational keratitides and dystrophies center around the problem of the traumatic factor in the etiology of the herpetic group of corneal diseases.

While herpes corneae and herpes zoster ophthalmicus are almost always unilateral conditions with rapid morphologic changes, bilaterality, steadiness of the morphologic picture and particularly absence of dendritic transformations characterize the occupational diseases. Powell's group of cases of unilateral involvement is to be explained by the possibility of unilateral voluntary closure of the eye permitted by the situation.

There is, however, a traumatic factor in herpetic disease to be considered per se. Schmidt [32] quoted Favery to the effect that trauma is a factor in the origin of herpes corneae in only 1 per cent of cases. In a study of a large group of cases of corneal disease of a herpetic nature Schmidt himself did not find trauma a factor in any of the cases of dendritic keratitis; a traumatic origin was discovered in only 1.8 per cent of the cases of superficial punctate keratitis but in 17.4 per cent of the cases of vesicular keratitis and in 20 per cent of the cases of relapsing erosions. He suggested that an interval of from two to five days should elapse between trauma and the onset of disease before a causal relationship is considered. Schieck [33] pointed out that since Busacca has demonstrated the herpes virus in unaffected conjunctivas and since the transmission of herpes to the rabbit's cornea is done by means of direct inoculation into

30. Wagenmann, A.: Die Verletzungen des Auges, in Graefe, A., and Saemisch, T.: Handbuch der gesamten Augenheilkunde, ed. 3, Leipzig, Wilhelm Engelmann, 1915-1925.

31. Thies, O.: Die Verlätzungen des Auges, Stuttgart, Ferdinand Enke, 1938.

32. Schmidt, K.: Herpes corneae und Trauma, Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **50**:217, 1934.

33. Schieck, in discussion on Schmidt,[32] p. 231.

the cornea, one should feel freer in accepting a traumatic factor and that one day is to be considered as the period of incubation. Gundersen,[19] in his study of 250 cases of herpes corneae, reported that the origin was probably traumatic in 5.2 per cent; he stated that the "most that can be said is that when the disease closely follows a definite trauma, it is probable that the trauma is the exciting cause." Ammann [34] reported cases of traumatic herpes corneae and 6 cases of keratitis superficialis interstitialis traumatica, the description of which corresponds to what one would call disciform keratitis, following apparently trivial corneal injuries. The same has also been seen by me. Ammann [35] also reported a group of 10 cases of herpes zoster ophthalmicus traumaticus from the literature. At the Bureau of Workmen's Compensation the percentage of cases of traumatic herpes cornea would of course be much higher than the foregoing figures would indicate.

SUMMARY

Occupational superficial punctate keratitis and dystrophy are often diagnosed as subacute or chronic conjunctivitis and as band-shaped keratitis and the true nature of the conditions overlooked without the use of the slit lamp.

Three types of this form of keratitis may be recognized. The first is an acute or subacute occupational superficial punctate keratitis, apparently due to particulate matter in spraying processes which clings to the corneal epithelium rather than to gases. This type is not important and to judge from the small number of cases seen, is evidently successfully combated in the state of New York by the safety measures employed. The second type is a chronic occupational superficial punctate keratitis verging on a dystrophy and apparently due to hard and sharp spicules penetrating the cornea, such as silica or metals. This type is more important because of the hypesthesia, but is also not common and is seen only among the older workers, being principally due to exposures in the presafety era. The third type is an occupational band-shaped keratitis seen at the bureau in the form of a post-traumatic lime band. Medicolegally, an interval of from one to five days is to be considered a requisite for a causal relation between a corneal injury and a herpetic corneal disease.

The problem of prevention of occupational keratitides and dystrophies is essentially one of safety engineering.

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34. Ammann, E.: Herpes traumaticus und Art. 91 K. U. G., Schweiz. med. Wchnschr. **63**:809 (Aug. 19) 1933; Keratitis superficialis-interstitialis traumatica, Klin. Monatsbl. f. Augenh. **91**:253 (Aug.) 1933.

35. Ammann, E.: Herpes zoster ophthalmicus traumaticus, Klin. Monatsbl. f. Augenh. **95**:793 (Dec.) 1935.

News and Notes

SOCIETY NEWS

American Ophthalmological Society—The American Ophthalmological Society will celebrate the seventy-fifth anniversary of its founding at a meeting to be held at the Homestead, Hot Springs, Va., June 5 to 7. In memory of the distinguished ophthalmologists who were instrumental in organizing the first society of medical specialists in the United States, the program of the usual three day meeting has been augmented to include a banquet, at which papers bearing on the relation of this society to the development of ophthalmic science will be read. At the banquet the history of the society will be presented in a paper by Dr. Harry Friedenwald, of Baltimore, who has been a member since 1894. Mr. H. M. Traquair, of Edinburgh, Scotland, will be the invited guest. At the first meeting of the society, held on June 7, 1864, at the New York Eye Infirmary, Dr. Edward Delafield, of New York, presided. He was reelected to serve as president for four successive terms. A fitting tribute to the society's first president will be presented at the banquet by Dr. Bernard Samuels, who will read a paper on the life and influence of Dr. Delafield.

International Association for the Prevention of Blindness.—The International Association for the Prevention of Blindness, which maintains a secretariat in Paris, will hold its next annual meeting in London, England, April 19, 1939. The principal topic for discussion will be "The Application of the Credé Method for Prevention of Blindness in Various Countries." The United States will be represented by Dr. Conrad Berens, of New York, a member of the board of directors of the National Society for the Prevention of Blindness; Dr. Park Lewis, of Buffalo, vice president of both the International Association and the American National Society, and Dr. Harry S. Gradle, of Chicago, vice president of the Illinois Society for the Prevention of Blindness.

North of England Ophthalmological Society.—The North of England Ophthalmological Society will sponsor an ophthalmologic tour, visiting New York, Philadelphia and Washington. The group is scheduled to reach New York on Sunday, April 30, remaining there until Friday, May 5. The visiting ophthalmologists will spend Saturday and Sunday, May 6 and 7, in Philadelphia and May 8 and 9 in Washington and will leave New York on Wednesday, May 10. Optional extensions for sight-seeing are available. The tour will be conducted by Thomas Cook & Son, Ltd.

Puget Sound Academy of Ophthalmology and Otolaryngology.—Dr. J. Edward Clark, Seattle, Wash., was recently elected president of the Puget Sound Academy of Ophthalmology and Otolaryngology; Dr. W. A. Cameron, Tacoma, Wash., was elected vice president and Dr. Purman Dorman, Seattle, secretary-treasurer.

German Ophthalmological Society.—The next meeting of the German Ophthalmological Society will be held in Heidelberg on Sept. 4-6, 1939. One principal topic will be considered, and there will be many papers on individual subjects. The Graefe medal will be awarded to a representative of the family of the late Jules Gonin.

GENERAL NEWS

Sight-Saving Classes.—The National Society for the Prevention of Blindness has announced that it is cooperating with the following colleges and universities in offering at their 1939 summer sessions courses for the preparation of teachers and supervisors of sight-saving classes:

Western Reserve University, Cleveland, June 19 to July 28. Director of the course: Miss Olive S. Peck, supervisor of Braille and sight-saving classes, Board of Education, Cleveland.

State Teachers College, Buffalo, June 26 to August 4 (dates tentative). Director of the course: Miss Agnes Reuter, Department of Special Education, Buffalo Public Schools.

State Teachers College, Milwaukee, June 26 to August 4. Director of the course: Miss Marguerite L. Kastrup, supervisor of Braille and sight-saving classes for Northern Ohio, Cleveland.

University of California, Los Angeles, June 26 to August 4. Director of the course: Miss Frances Blend, principal of sight-saving classes, Los Angeles City Schools.

Wayne University, Detroit, June 26 to August 4 (elementary and advanced courses). Director of the elementary course: Mrs. Gladys Dunlop Matlock, Detroit. Director of the advanced course: Mrs Winifred Hathaway, associate director, National Society for the Prevention of Blindness, New York.

Details regarding the courses may be obtained from the university or college or from the director in charge of the course.

Ophthalmologica, International Journal of Ophthalmology.—*Ophthalmologica* is the continuation of the *Zeitschrift für Augenheilkunde*. It now appears as an international journal of ophthalmology. Prof. A. Brückner, of Basel, Switzerland, and Prof. H. Weve, of Utrecht, Netherlands, are the new editors. There is an imposing list of co-editors who represent practically all countries in the world. The journal will continue to be published monthly, by S. Karger, in Basel; six numbers will make a volume, the price being 30 Swiss francs ($6).

The original articles are to appear in any one of three languages, German, English or French, with summaries in all three languages. A report on ophthalmologic literature, society reports, a chapter on diagnosis and therapy and book reviews complete the number.

PERSONAL

Dr. Phillips Thygeson has been appointed executive officer of the department of ophthalmology in Columbia University's College of Physicians and Surgeons. Dr. John H. Dunnington has been made clinical director. Both Dr. Thygeson and Dr. Dunnington were promoted to full professorships.

Obituaries

RICHARD GREEFF, M.D.
1862-1938

Richard Greeff, the son of a professor of zoology in the University of Bonn, received an early introduction to the natural sciences. He obtained his ophthalmologic training from Schweigger and was appointed professor of ophthalmology in the University of Berlin. He was entrusted with the formation of the ophthalmic department at the Charité Hospital in Berlin in 1897, which he conducted until the time of retirement on account of age limit in 1927. During these years the department grew steadily, and Greeff established his reputation as teacher, clinician and scientist. His course on the pathology of the eye was popular and attracted many young ophthalmologists from all parts of the world. His histologic investigations began with the structure of the retina, in which he employed the methods of Ramón y Cajal. He was one of the first ophthalmologists to write a textbook on the pathology of the eye. His clinical investigations were concentrated on trachoma, and he was one of the discoverers of the inclusion body.

Of marked artistic leaning, he repeatedly visited the art treasures of Italy and Spain. There he discovered ophthalmologic points of interest in the works of art, such as Rembrandt's portrayal of Tobias' blindness and recovery, which he described in an interesting monograph. Greeff made an important collection of eye glasses and spectacles, to which were added ophthalmoscopes, surgical instruments and memorabilia pertaining to von Graefe. These are all on exhibition in the Kaiserin-Friedrich Museum in Berlin.

ARNOLD KNAPP.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

TOPOGRAPHY OF THE VENAE VORTICOSAE. G. BASILE, Ann. di ottal. e clin. ocul. **66**: 100 (Feb.) 1938.

Because of the necessity for locating the venae vorticosae during operations for retinal detachment, the author studied their location in 39 eyes of cadavers. The eyes were injected to normal tension with a fine needle, and measurements were made of three factors relating to each vein: (1) the distance from the limbus to the center of the insertion of the superior and inferior rectus muscles, (2) the distance from the limbus to the scleral outlet of each vein and (3) the distance between the outlet of each vein and the center of the insertion of the superior rectus muscle for the two upper veins and of the inferior rectus muscle for the two lower veins. A triangle was formed, therefore, uniting the center of the cornea with the venous outlet and the center of the nearest insertion of the rectus muscle. The angle of the two lines with the corneal vertex was calculated for each vein, and graphs were made showing the relative frequency of the various angles at which the veins were found.

The distance of the superior temporal vein from the limbus varied from 16 to 19.8 mm.; that of the superior nasal vein, from 16 to 20.5 mm.; that of the inferior temporal vein, from 15.5 to 19.5 mm., and that of the inferior nasal vein, from 15 to 19 mm. The veins emerged most frequently along a meridian nearer to the vertical than to the horizontal meridian, the angle with the vertical meridian being most frequently between 25 and 30 degrees. S. R. GIFFORD.

Bacteriology and Serology

ALLERGIC OCULAR REACTIONS. V. SPADAVECCHIA, Ann. di ottal. e clin. ocul. **66**: 241 (April) 1938.

The phenomenon of Auer was produced in rabbits by sensitizing them to horse serum and after a suitable period injecting a large dose of the serum (10 cc.) intraperitoneally, followed by the instillation of an irritating chemical in the eye. When 2 drops of chloroform was employed, the initial period of hyperemia and edema due to the chemical was followed after several days by severe iritis, which persisted till the eighth day. This reaction was absent in the 2 control animals, 1 of which was sensitized but was not given a toxic dose of serum, while the other received the toxic dose without previous sensitization. The iritis which occurred in the sensitized animals which were given a second injection of serum must be considered an allergic phenomenon. The irritating chemical, by producing hyperemia and increasing capillary permeability, produced fixation of the heterologous protein in the ocular

tissues, resulting in an intense local reaction. Later instillations of chloroform in sensitized rabbits produced much slighter reactions. When the chloroform was diluted with two parts of liquid petrolatum, the difference between the control and the sensitized animals was more clearcut, the control showing a slight and brief reaction, while the sensitized animal showed a dense area of central corneal infiltrations with subsequent vascularization, accompanied by iritis, which persisted for a month.

When other irritants, such as histamine and uric acid, were employed, inflammation of the conjunctiva and in some cases of the iris resulted in the sensitized animals. The instillation of horse serum in sensitized animals produced only a slight and brief reaction, while its subcutaneous or retrobulbar injection produced marked swellings, which persisted for a number of days (phenomenon of Arthus). In all the experiments the most severe reactions were produced in animals which were sensitized and after an interval given a large dose of serum. Less intense reactions were seen in animals which were sensitized but were not given a toxic dose of serum at the time the chemical was applied.

S. R. GIFFORD.

Biochemistry

OCCURRENCE OF ACETYLCHOLINE ESTERASE IN THE AQUEOUS HUMOR AND VITREOUS BODY. BÖRJE UVNÄS and HERBERT WOLFF, Acta ophth. **16:** 157, 1938.

The authors, using the eyes of cattle and of horses, studied the hydrolytic action of aqueous and vitreous on acetylcholine. The method adopted involves colorimetry and is a modification of the technic for the estimation of acetylcholine esterase in blood serum. The article is summarized as follows:

Practically no acetylcholine esterase could normally be detected in the aqueous of bovine eyes. Only under certain conditions; viz., after postmortem changes, and more especially after a previous partial emptying of the anterior chamber, could enzyme activity be detected.

Considerable quantities of acetylcholine esterase were found in the vitreous of bovine eyes. The esterase activity of the vitreous corresponds approximately to one eighth of that found in blood from man and horse. In vitreous from the horse the activity of acetylcholine esterase was found to be much less.

The enzyme activity that appears under certain conditions in aqueous may conceivably be derived from inflowing or indrawn vitreous.

O. P. PERKINS.

Conjunctiva

TREATMENT OF GONORRHEAL CONJUNCTIVITIS WITH SULFANILAMIDE. A. MAGITOT, A. DUBOIS-POULSEN and Y. GEFFROY, Bull. Soc. d'opht. de Paris **50:** 82 (Feb.) 1938.

The literature and history of the drug are reviewed. Five cases are cited in some detail. These cases do not warrant precise conclusions but point the way to miraculous cures of this disease. The question of dosage is extremely important. The authors believe that the rule of

1 Gm. of the drug to every kilogram of body weight, as proposed by Schwentker and Clason, should be adopted. Cyanosis, dermatoses and anemia are the complications that should be contraindications for continued treatment.

L. L. MAYER.

CHEMOTHERAPY OF BLENNORRHAGIC CONJUNCTIVITIS WITH SULFANILAMIDE. R. PAGES and J. DUGUET, Bull. Soc. d'opht. de Paris 50: 94 (Feb.) 1938.

Three cases of blennorrhagic conjunctivitis in which sulfanilamide was given are reported in detail. Outstanding benefits from this form of therapy are loss of photophobia, disappearance of pain, failure to secure positive cultures in short periods after treatment is begun and lessening of the purulent secretion. Local treatment should be continued in connection with the drug. The drug seems specific.

L. L. MAYER.

PARINAUD'S CONJUNCTIVITIS AND PAROTITIS (RELATION TO HEERFORDT'S SYNDROME). C. THOMAS, Bull. Soc. d'opht. de Paris 50: 382 (June) 1938.

Since 1889, when Parinaud described "a conjunctival infection of animal origin," the etiology of this condition has been much discussed. Numerous organisms have been described as causing preauricular adenitis and conjunctivitis. A recent patient of Thomas was given a thorough bacteriologic examination by Professor de Lavergne, of Nancy, France. The lesion was a monopalpebral granuloma of the conjunctiva with preauricular adenopathy, which receded in a number of weeks of its own accord. All tests for organisms and general disease were negative. Biopsy of the glandular tissue and the granulomatous conjunctiva revealed changes similar to those reported by Besnier, Böeck and Schaumann. Thomas feels that the condition is perhaps a more localized phase of the uveoparotitis of Heerfordt. His reasons are as follows: 1. The conjunctival granulations are similar to those described by Toulant and Morard in Heerfordt's disease. 2. Tumefaction of the preauricular gland is similar. 3. The evolution and spontaneous healing are similar, except that uveoparotitis may last a little longer. 4. Histologically, a benign lymphogranuloma exists in each disease.

L. L. MAYER.

Congenital Anomalies

ANIRIDIA CONGENITA, IRIDEREMIA. E. M. NEHER, Am. J. Ophth. 21: 293 (March) 1938.

After a discussion of aniridia and a presentation of genealogic studies, Neher gives the following summary:

"The part of the aniridic family tree upon which accurate data could be obtained has verified the Mendelian inheritance law; that is, one half of the offspring possess the dominant character—aniridia—while the

other half possess a normal iris. Furthermore, when the aniridic offspring are mated with normal individuals and have children, 50 per cent are aniridic and the remainder have a normal iris; but the normal offspring who marry normal individuals never have borne children with aniridia. The amount of iris present varies from complete aniridia to a small coloboma of the iris."

W. S. REESE.

Cornea and Sclera

SYNDROME OF BLUE SCLEROTICS (VAN DER HOEVE). J. S. CHARAMIS, Ann. d'ocul. **175:** 738 (Oct.) 1938.

The author states that for the first time in Greece it has been possible to study four generations in a family many members of which presented a van der Hoeve syndrome, either partial or complete.

This syndrome presents three classic symptoms: a blue sclera, multiple fractures and otosclerosis. In 1829 Lobstein first reported the constitutional predisposition of certain persons to fractures. Eddowes in 1901 reported that a blue sclera is often present in such persons. He also demonstrated the familial and hereditary character of the condition. In 1916 van der Hoeve and Klein added deafness as the third principal symptom. Practically all authors are agreed that the condition is a familial one and due to heredity.

It was seen in the family here studied that persons in perfect health had descendants who presented in part the syndrome in question. Certain families may present one of the three symptoms, such as deafness or a blue sclera or bone fragility, or two of these symptoms may be present. In the family here described the males seemed to be more afflicted than the females.

A description of the four generations is given in detail.

S. H. MCKEE.

Experimental Pathology

RETURN OF VISION AND OTHER OBSERVATIONS IN GRAFTED VERTEBRATE EYES. L. S. STONE, Am. J. Ophth. **21:** 1 (Jan.) 1938.

On the basis of this interesting study of grafted vertebrate eyes, Stone presents the following discussion and conclusions:

"It is clear that the functional eye of the urodele can be readily grafted, even several times, with complete recovery of all its functions so long as it is placed in its normal environment, the orbit. It is also obvious that the nature of the degenerative changes that take place in the grafted eye and the amount of regeneration required to bring about recovery depend upon the age of the host. The ability of the young eye to undergo transplantation with so little subsequent change in its structure, and the power exhibited by the adult eye to regenerate a new lens and retina after considerable destruction explain the high percentage of success in these experiments. The homoplastic transplantations seem to be about as successful as the autoplastic (reimplanted) graft. Even between closely allied species (Stone, '30) the

heteroplastic grafts are equally tolerated. Between the adults of more distantly related species (A. punctatum and T. viridescens) there appears to be incompatibility between host and graft tissues. This is not entirely mutual, however, because the Amblystoma eye upon Triturus can remain in good condition for several months. The reverse is not true.

"It remains to be seen whether or not there are any groups of vertebrates in which the eye can be so successfully grafted as in the amphibians. The works of Blatt ('24) and Ask and Andersson ('27) in grafted eyes, and the experiments of Matthews ('33) on cutting the optic nerve seem to give some evidence that the power of restitution in the operated eye in some of the fishes is not so great as in amphibians. The experimental work that we have begun in this class of vertebrates has also given us information that in Fundulus this is quite true. What differences there will be found in the various groups of fishes awaits further experimentation. There is no evidence existing at the present time.

"Among the other classes of vertebrates there is also no satisfactory information on this score. What little has been done tends to indicate negative results in the grafting of the eye in the higher forms, for in them regeneration of lost parts in the more specialized tissues seems to be rather poorly developed. Favorable findings in the grafted eye of the rat were published by Koppanyi ('23) but these results do not seem to have been corroborated. Our own unpublished experiments on more than 100 rats of various ages after birth indicate that anatomical healing in the grafted eye of the white rat is difficult to obtain. A reimplanted eye existing for about four months, one fourth of its original size, represented the best results in our series. The retina degenerated without the slightest evidence of recovery. However, the grafting of the eye of the mammal in general has not been investigated sufficiently to give an idea how much can be done. Therefore the results so far do not necessarily mean that better success is not possible in some other mammal.

"The size of the eye and the part it plays in delaying the return of circulation to distant parts of the bulb is no doubt one of the important features which extends the degenerative changes to the point where restitution becomes impossible. It is quite possible that in only those animals which exhibit exceptional powers of regeneration can we expect the eye to survive an operation such as grafting."

W. S. Reese.

General Diseases

Clinical and Pathologic Changes in Brucellosis. M. S. Nikolaeva, Vestnik oftal. **11**: 187, 1937.

A review of the historical, geographic and clinical data concerning ocular lesions in cases of brucellosis is given. The serologic and allergic tests are important in establishing a correct diagnosis. Two cases are reported by Nikolaeva. In 1 of these the patient, a man aged 29,

presented a deep keratitis and uveitis of both eyes with a subfebrile temperature. Wright's reaction of the blood was positive in dilutions of 1:50 and 1:200; Burnet's reaction was also positive, so that the diagnosis of a mild brucellosis was made. In the second case the patient, a man aged 60, presented a severe "typhoid-like" condition with a number of complications and a markedly positive Wright's reaction of the blood (dilution, 1:500). There were hemorrhages in the anterior chamber and in the vitreous of the right eye. In the left eye there was total ophthalmoplegia. Both eyes were removed at autopsy and examined. Six photomicrographs illustrate the pathologic changes in the eyes. Nikolaeva arrives at the following conclusions:

1. The ocular lesions in brucellosis vary greatly. There may be a superficial or a deep keratitis, iridocyclitis or inflammation of the optic nerve.

2. The process is localized more frequently in the anterior part of the uvea. The clinical picture is not typical; the diagnosis is therefore difficult and can be established more accurately by the means of serologic and allergic reactions.

3. The paralysis of the oculomotor nerve is associated with severe lesions in the central nervous system.

4. Ocular lesions are observed in "ambulatory" patients with mild brucellosis and in those with the severe "typhoid-like" type of brucellosis.

5. The pathologic changes of the eye in cases of brucellosis give a picture of diffuse, nonspecific, chronic inflammation with a tendency to hemorrhages and a mild degree of exudates without the formation of specific granulomas. (This is confirmed by experimental brucellosis.) A detachment of nonpigmented epithelium of the ciliary body was observed which resembled the process of sympathetic ophthalmia.

O. SITCHEVSKA.

General Pathology

SENILE CHANGES AND DEGENERATIONS OF THE HUMAN EYE. B. RONES, Am. J. Ophth. **21**: 239 (March) 1938.

This interesting article does not lend itself to abstracting. Rones discusses the senile changes in the different structures of the eye and their possible clinical applications. He gives the following summary:

"Analyzing the factors contributing to the diversity of senile changes in the ocular tissues leads to the conclusion that the vascular changes are of fundamental importance. Impaired nutrition resulting from this will explain the deposition of fat globules in the various structures. It is also well known that initial proliferative changes leading to subsequent degenerations are attributable to faulty circulation. The old adage that 'a man is as old as his arteries' can thus be also applicable to the changes that occur in the eye during advancing years." W. S. REESE.

Glaucoma

RECENT ADVANCES IN THE SURGERY OF CHRONIC GLAUCOMA. O. BARKAN, Am. J. Ophth. **20**: 1237 (Dec.) 1937.

Following a discussion relative to his recently presented operation, Barkan gives the following summary:

"1. The procedure of opening Schlemm's canal under direct vision involves a new principle in the surgery of glaucoma in that a hitherto hidden area of the inside of the eyeball (Schlemm's canal and the angle of the anterior chamber) is made visible during operation.

"2. The surgeon can see the area of blockage during the operation and can actually watch and guide his instrument in restoring the normal direction to the circulation of intraocular fluid.

"3. The operation is without danger when the proper technique is used and has proved successful when certain preoperative indications (biomicroscopic diagnosis) have been fulfilled.

"4. The results are predictable and appear to be permanent. However, a much longer period of observation will be necessary to give a definite answer to the question of permanency of results.

"5. The operation is especially indicated in chronic simple glaucoma (type 1 of the writer). It is equally successful in certain cases of secondary glaucoma and gives promise of being applicable also in certain other cases of primary glaucoma.

"6. The pathologic anatomic entity described by the writer as chronic glaucoma, type 1, appears to cover "chronic simple glaucoma," and "anterior glaucoma."

"7. Certain conclusions in regard to the etiology and symptomatology of chronic simple glaucoma may be fairly drawn.

"8. Biomicroscopy of the angle of the anterior chamber is a useful adjunct to diagnosis and often enables an earlier diagnosis of glaucoma than has hitherto been possible. It would seem to constitute a considerable advance in the management of glaucoma.

"9. The operation of opening Schlemm's canal under direct vision may assist in the solution of the surgical problem of chronic glaucoma."

W. S. REESE.

SIMPLE CHRONIC GLAUCOMA AND ITS CONNECTION WITH CONGENITAL ANOMALIES OF THE EYE. A. F. RUMIANTZEVA, Vestnik oftal. **11**: 348, 1937.

Rumiantzeva reports 5 cases of simple chronic glaucoma in persons between the ages of 20 and 35 with various congenital anomalies, such as heterochromia, aniridia, microcornea, coloboma of the iris and polycoria. The condition was bilateral as a rule. She believes that because of atrophy and defects in the iris there is a disturbance of the filtration in the angle of the anterior chamber, in Schlemm's canal or in the perivascular space of the vorticose veins due to the abnormal development of the eye in embryonic life. Since at the aforementioned ages

the sclera is firm, no hydrophthalmos develops. Early diagnosis and control of simple glaucoma are urged.

The literature on the subject is reviewed. O. SITCHEVSKA.

Injuries

REMOVAL OF LEAD SHOT FROM THE VITREOUS BY USE OF THE BIPLANE FLUOROSCOPE. W. E. BORLEY and E. LEEF, Am. J. Ophth. **20:** 1232 (Dec.) 1937.

• Borley and Leef report a case of extraction of lead shot from the vitreous by a modification of Cross' method. They give the following conclusions:

"(1) It is possible to remove lead shot or other nonmagnetic intraocular foreign bodies with the help of the double-plane fluoroscope. (2) The serious complications of retinal detachment which frequently follow extraction of these foreign particles, may be prevented by application of diathermic microcoagulation. (3) Early operation is essential to the maintenance of good vision." W. S. REESE.

OPERATIVE CLOSURE OF PERFORATING WOUNDS OF THE CORNEA. E. HERTEL, Arch. f. Ophth. **139:** 1 (Aug.) 1938.

Of the two available methods for treating perforating wounds of the cornea, corneal suture or covering and bracing of the wound with a conjunctival flap, the former affords closer approximation and apposition of the lips of the wound. The author carries the corneal sutures through the anterior half of the cornea and through a previously prepared conjunctival flap. The sutures are tied on the anterior surface of this flap, damage to the corneal surface by the threads and knots thereby being avoided, and the flap is held in place. Numerous drawings of pathologic sections illustrate the various (histologic) modes of closure of corneal wounds. P. C. KRONFELD.

Lacrimal Apparatus

TREATMENT OF CONGENITAL ATRESIA OF THE NASOLACRIMAL DUCT. S. LARSSON, Acta ophth. **16:** 271, 1938.

The nasolacrimal duct may be longer than the bony canal containing it. In such cases the duct continues below the orifice of the bony canal, the medial wall of the duct being covered by nasal mucous membrane. The normal opening of the duct may form a window on the medial wall above the end of the duct. For this reason there are certain patients with congenital atresia of the lacrimal duct who cannot be successfully treated by probing, for the probe passes to the floor of the nasal fossa without producing a perforation medially. In 2 such instances the author has removed the tip of the inferior turbinate and incised the mucosa against a probe which had previously been introduced in the usual way.

O. P. PERKINS.

Lens

CATARACT ASSOCIATED WITH AN HEREDITARY RETINAL LESION IN RATS. M. C. BOURNE, D. ADAMS CAMPBELL and M. PYKE, Brit. J. Ophth. **22:** 608 (Oct.) 1938.

The animals studied were bred from cataractous rats which were otherwise healthy and did not suffer from dietary deficiency or traumatic injury. The cataracts appeared in successive generations. The authors were satisfied that some hereditary factor was concerned in their production.

Histologic examination showed that although the iris and ciliary body were normal, cataractous changes in the lens were invariably associated with a typical form of retinal degeneration.

The variations in the time of onset and in the rate of development suggested that the cataract is a secondary but not a "terminal complication" resulting from retinal disintegration. There were occasional persistent remnants of the hyaloid artery and fibrous strands in the vitreous.

Illustrations accompany the article. W. ZENTMAYER.

THE CHOLESTEROL CONTENT OF NORMAL AND OF CATARACTOUS HUMAN LENSES. E. BUNGE, Arch. f. Ophth. **139:** 50 (Aug.) 1938.

The cholesterol content of clear human lenses extracted post mortem was found to increase with age (colorimetric determination of the digitonin precipitate). At the age of 70 the lens contained about six times as much cholesterol as at the time of birth. Fifteen intra vitam (intracapsularly) extracted cataractous lenses were analyzed and found to contain essentially the same amounts of cholesterol as clear lenses of persons of the same age if the difference in water content between mature cataracts and clear lenses was taken into consideration.

P. C. KRONFELD.

Methods of Examination

QUANTITATIVE PERIMETRY IN GLAUCOMA WITH OBJECTS OF VARYING LUMINOSITY. J. ROLL, Klin. Monatsbl. f. Augenh. **100:** 600 (April) 1938.

Roll examined the field of vision of glaucomatous patients with objects of reduced luminosity, as provided on Zeiss' projection perimeter. Using these objects in the dark room, he found that defects in the field of vision, noticed under usual conditions, were more distinct and more extensive. No difference was observed in cases of recent glaucoma in which perimetric examination or Bjerrum's screen had revealed an absence of defects. In cases of more advanced glaucoma distinct contractions were noticed in the field for white and colors, after a normal outline was found with bright objects. This method allows definite conclusions regarding the activity of the periphery of the retina in chronic glaucoma. Roll expects to gain some information as to the therapy.

K. L. STOLL.

Neurology

OCULAR SIGNS OF INTRACRANIAL DISEASE IN CHILDREN AND JUVENILES. E. W. NEWMAN, Am. J. Ophth. **21**: 286 (March) 1938.

Newman studied 42 cases of intracranial disease in children and juvenile patients and presents the following summary:

"1. Changes in the optic discs were found in 95.2 per cent of cases; this fact emphasizes the importance of an ophthalmoscopic examination in all children with findings which might in any way lead to a suspicion of intracranial disease.

"2. Loss of vision was registered as a complaint in only 23.8 per cent of the cases in spite of the fact that 95.2 per cent of the cases presented abnormalities of the optic discs. This is due to the fact that children do not appreciate failure of vision so readily as do adults, and that choked discs do not affect the vision for some time.

"3. Nystagmus was present in 21.4 per cent of the patients, all of whom had tumor of the brain and, with one exception, occurred with a tumor of the cerebellum.

"4. Of the total number of patients in this series, 55 per cent had brain tumors. Histological verification was possible in all except two cases, in which the cerebellar lesion was seen at the time of decompression. The optic discs were normal in only one case, a subtentorial lesion.

"5. A case of high-cervical-cord tumor associated with bilateral choked discs is reported, and a short review of the literature pertaining thereto is cited.

"6. This study emphasizes the extreme importance of a thorough ocular examination. The omission of a fundus examination is often the reason for failure in reaching a correct diagnosis; this is especially true in the case of children, in whom other examinations may be difficult."

W. S. REESE.

REDUCTION OF INCREASED INTRACRANIAL PRESSURE BY CONCENTRATED SOLUTIONS OF HUMAN LYOPHILE SERUM. JOSEPH HUGHES, STUART MUDD and EDWARD A. STRECKER, Arch. Neurol. & Psychiat. **39**: 1277 (June) 1938. REDUCTION OF CEREBROSPINAL FLUID PRESSURE BY CONCENTRATED LYOPHILE SERUM. DAVID WRIGHT, DOUGLAS BOND and JOSEPH HUGHES, ibid. **39**: 1288 (June) 1938.

Because variations in the osmotic pressure of the blood influence the intraocular as well as the intracranial pressure, the use of concentrated lyophile serum may become important clinically for the reduction of intraocular as well as of intracranial pressure.

Hughes, Mudd and Strecker, using a preparation of four times the concentration of normal serum, report in 7 patients an increase in blood pressure and a decrease in cerebrospinal fluid pressure for

relatively long periods. In 3 normal subjects they found this serum more effective than sucrose.

Wright, Bond and Hughes found that concentrated solution of serum in doses of 4 cc. per kilogram of body weight reduce cerebrospinal fluid pressure of dogs for relatively long periods, as indicated by continuous recording of cisternal pressure. Eight cubic centimeters of serum per kilogram of body weight maintained a reduction in pressure for longer than twenty hours.

The results of the animal experiments reported in the second paper confirm the clinical observations presented in the first paper.

R. IRVINE.

Ocular Muscles

A PHOTOGRAPHIC ANALYSIS OF ALTERNATING VISION DURING READING. B. CLARK, Am. J. Ophth. **20:** 1142 (Nov.) 1937.

Clark gives the following summary:

"The binocular behavior of a group of 10 university students was studied during control or bar-reading. All of the subjects showed normal exophoria at the reading distance. The results of this study lead to the following general conclusions:

"1. The alternating vision that occurs during bar-reading does not appreciably alter reading efficiency as measured by eye-movement photography.

"2. The bar-readers showed much more variation in binocular behavior than did a control group during normal reading. This variation was found both in convergence and divergence in reading through the lines, in spite of the fact that binocular vision was present for the last fixations at the ends of the lines."

W. S. REESE.

THE EFFECTS OF ANOXEMIA ON OCULAR MOVEMENTS WHILE READING. R. A. MCFARLAND, C. A. KNEHR and C. BERENS, Am. J. Ophth. **20:** 1204 (Dec.) 1937.

Following experiments on 20 patients, 8 of whom were controls, in a Barach oxygen chamber the following conclusions were made:

"1. A significant increase was found in the reading time of control and experimental patients in oxygen concentrations corresponding to 15,000 to 18,000 feet. A similar increase was found in the number of fixations. A significant increase in regressions was made by the experimental group and a slight decrease (not significant) by the control group.

"2. The visual axes of patients with normal refraction and muscle and those with diminished acuity, muscle imbalance, and heterotropias showed (1) divergent movements during reading fixations and (2) convergence during the saccadic movements in normal and reduced oxygen concentrations. Since this occurs even in esotropia it may be related to variations in vergence caused by changes in accommodative effort.

"3. A decrease in the extent of divergent movements occurred in reduced oxygen for both groups, and was significant for the controls at 18,000 feet.

"4. The data showed no statistical relationship to the eye examination for the two groups as a whole. When the photographic records were analyzed individually, however, significant alterations were observed which could be definitely related to the findings from the eye examinations.

"5. The general qualitative characteristics of the ocular movements for both groups showed a diminution of precision in oxygen want, with the appearance of nystagmoid movements, general unsteadiness, and accentuation of abnormalities.

"6. A decrease in comprehension of the reading material was observed for all of the patients in reduced oxygen. This may represent an impairment of perception or of memory for immediate recall.

"7. The data from 10 patients indicated a tendency toward acclimatization by the end of one hour at 13,000 feet (12.5 per cent O_2.). No such adjustment was detectable at 18,000 feet (10.5 per cent O_2.).

"8. Photographic records of ocular movements obtained during reading appear to be of some value in the diagnosis of clinical anomalies. This method objectively records the movements of the eyes in a normal situation. Under conditions of anoxemia the latent defects present become accentuated. Therefore, this procedure may be of clinical significance.

"9. The eye-movement photographs showed that reading time per line and adjustments during fixations were sensitive measures of the early effects of anoxemia.

"10. The decrease in efficiency of ocular movements under anoxemia may be attributed to the diminished amount of oxygen being delivered to the nervous tissue, subcortical as well as cortical." W. S. REESE.

Orbit, Eyeball and Accessory Sinuses

A COMPARATIVE STUDY OF EXPERIMENTAL AND CLINICAL EXOPHTHALMOS. G. K. SMELSER, Am. J. Ophth. **20**: 1189 (Dec.) 1937.

Smelser reviews the theories of the cause of exophthalmos in exophthalmic goiter and some of the experimental work; he also reviews the clinical data, this consisting mainly of biopsies in 6 cases. Approximately 100 young adult guinea pigs were used. Of these, 50 were thyroidectomized, and one cervical sympathetic ganglion was removed from half of them. Both males and females were included, some of them being gonadectomized. They were fed normal stock diet. The extract used was prepared from acetone dried bovine anterior pituitary lobes from which the posterior lobes had been carefully removed. Thyroidectomy had no obvious effect on the eyes. Removal of the cervical sympathetic ganglion produced a definite ptosis, enophthalmos and a small pupil in the effected eye. Injection of the pituitary extract into normal guinea pigs produced no demonstrable effect, whereas in all but 3 of the thyroidectomized animals a definite and, in some instances, an extreme exophthalmos was induced, this usually appearing in from ten to twenty

days. After enumerating the histologic changes and discussing them, Smelser gives the following summary:

"Clinical

"1. Exophthalmos in the cases studied was due to excess orbital tissue.

"2. Retrobulbar connective tissue, fat, and muscles were edematous and infiltrated with wandering cells.

"3. Similar changes were found in hyper and hypothyroid cases.

"4. Extraocular muscles were enlarged, though muscle-fiber degeneration was not striking.

"Experimental

"1. Exophthalmos due to increased orbital tissue was produced in thyroidectomized guinea pigs.

"2. Retrobulbar connective tissue, fat, and muscles were infiltrated with edematous material indistinguishable from that in clinical cases.

"3. Exophthalmos persisted post mortem.

"4. Removal of the cervical sympathetic ganglion did not inhibit the increase in orbital tissues.

"5. Areas of round-cell infiltration were found in the fat and muscles."

W. S. REESE.

ABNORMAL PNEUMATIZATION OF THE SPHENOID SINUS AND OPTIC NEURITIS. L. GIACOBBI, Riv. oto-neuro-oftal. **14:** 317 (May-June) 1937.

Giacobbi is of the opinion that roentgenographic examination of sinuses should be made in cases of optic neuritis not only to ascertain the presence of infection but to obtain the dimensions of the sphenoid sinus. He reports 3 cases of optic neuritis in which no infection could be found on rhinoscopic or roentgenographic examination. The sphenoid sinuses were unusually large, and Giacobbi is of the opinion that this was the factor responsible for the disease of the optic nerve.

In such cases opening the sphenoid sinuses seems to have a definite beneficial effect.

F. P. GUIDA.

Physiologic Optics

ENTOPTIC IMAGES OF THE PUPIL SEEN BY DOUBLE REFLECTION THROUGH EYE GLASSES. G. SANNA, Ann. di ottal. e clin. ocul. **66:** 282 (April) 1938.

The author attempts to explain a phenomenon noted by himself and others. When a person wearing glasses enters a room lit by an intense electric light, with the gaze directed to the less illuminated wall, a luminous disk is seen with either eye. It varies in size with the distance of the glasses from the eye and with the power of the convex lens employed, becoming larger as the power of the lens increases and smaller as the lens is removed from the eye. The author proves by optical

theory and experiment that the image is that of the pupil reflected first from the corneal surface and then from the posterior surface of the lens. If the lens is increased in power, a second smaller image, corresponding to reflection from its anterior surface, is seen.

S. R. GIFFORD.

Physiology

PRESSURE OF THE CENTRAL RETINAL ARTERY IN RELATION TO THE CAROTID SINUS REFLEX. C. GANDOLFI, Ann. di ottal. e clin. ocul. **66:** 132 (Feb.) 1938.

Compression of the carotid sinus at the level of the upper margin of the thyroid cartilage produces in man a slowing of the pulse. The opposite effect is produced by compression of the common carotid artery. The author noted the diastolic retinal pressure with Bailliart's dynamometer in 20 normal youths and young adults before and during compression of the sinus. The general blood pressure showed a rise of from 10 to 25 mm. during compression, and the diastolic retinal pressure rose from 5 to 20 mm. The rise in pressure on the side on which compression was made and on the opposite side was the same, a result which differs from Baurmann's findings. The effect is due to a vasomotor reflex.

S. R. GIFFORD.

DARK ADAPTATION IN SLIGHTLY PIGMENTED AND ALBINOTIC EYES: REPORT OF CASES. E. BUNGE and W. HEYN, Klin. Monatsbl. f. Augenh. **100:** 178 (Feb.) 1938.

The authors describe the technic and calculations used in their study of dark and light adaptation, which were devised in a manner to avoid errors. They examined 8 albinotic patients and a young man with normal pigmentation except for an albinotic fundus. The course of dark adaptation was recorded in graphs. The apparatus of Drescher and Trendelenburg was used for light adaptation, and the values were registered with an adaptometer devised by Engelking and Hartung. The values for the dark adaptation of normal eyes were found with the same method by examining the eyes of 20 normal persons. Patients with total albinism, who were examined repeatedly, showed the same figures for the beginning and final adaptation as normal persons. Ten light blond persons presented the same course and type of adaptation as 10 persons with dark hair.

K. L. STOLL.

Refraction and Accommodation

NEAR VISION IN MYOPIA. E. DI BARI, Arch. f. Ophth. **139:** 105 (Aug.) 1938.

Because of the larger images which the retina of the myopic eye receives, clear vision without correction is possible at distances from the eye which slightly exceed that of the punctum remotum. The author, a physicist, deals with this phenomenon mathematically.

P. C. KRONFELD.

Retina and Optic Nerve

THE INDIRECT TRAUMATIC OPTIC ATROPHIES. M. DAVIDSON, Am. J. Ophth. **21:** 7 (Jan.) 1938.

Davidson makes the following conclusions in this rather comprehensive article on indirect traumatic atrophy of the optic nerve:

"1. The condition may properly be described as a syndrome involving a certain type of accident, namely, falls from heights, and an evolution with immediate blindness, abolition of the direct reaction to light, without fundus changes at first, and optic atrophy in from one to three weeks.

"2. It is the result of accidents, principally industrial, among workers engaged in the building trade, in which falls are likely, rather than of compound skull fractures or of war injuries.

"3. The bilateral cases and the chiasmal syndromes are probably a more common but easily overlooked condition; lues and other intracranial pathology are factors to be considered in the bilateral cases, principally.

"4. The field defects observed suggest a diffuseness of optic-nerve and chiasm lesions rather than isolated bundle defects; the relation between the foramen fracture and the optic-nerve lesions is apparently the same as the relation between skull fracture and brain injury in general, and is not determined by the site of fracture; contralateral involvement is not rare.

"5. The apex syndrome, that is, involvement of optic foramen and sphenoidal fissure simultaneously, is rare, and when present it is the sixth nerve that is most frequently involved.

"6. All unilateral optic atrophies, remaining so under long observation and following a head injury, even minor, are to be regarded as the result of the head injury regardless of X-ray findings or history of unconsciousness.

"7. In industry, in the absence of routine preemployment and periodic eye examinations, an early inquiry into the condition of the eyes after every head injury, irrespective of its mildness, is essential not only for diagnosis and prognosis, but for the elimination of medicolegal controversies and of prevention of miscarriage of justice."

W. S. REESE.

OCULOCARDIAC REFLEX OBSERVED AFTER AN OPERATION FOR DETACHMENT OF THE RETINA BY DIATHERMOCOAGULATION. P. MICHAND, Bull. Soc. d'opht. de Paris **50:** 136 (March) 1938.

The patient, 20 years of age, had a detachment of the superior internal quadrant of the retina following an injury. There was no hematoma of the ocular region. The general condition and pulse were normal. Sixteen hours after operation the pulse had a normal rhythm but had dropped to between 40 and 44 pulsations per minute. The respiration was likewise slightly retarded. A retrobulbar hemorrhage was considered, although it could not properly be verified. An immediate injec-

tion of alcohol was made retrobulbarly, and the pulse rate returned to 60 per minute.

Other patients who were operated on for various conditions showed a slowing of the pulse rate. The latency of the reaction and its probable mode of transmission are commented on. L. L. MAYER.

THORACOCERVICAL SYMPATHECTOMY IN THE TREATMENT OF RETINITIS PIGMENTOSA. A. CHIASSERINI and I. NEUSCHÜLER, Riv. oto-neuro-oftal. **14:** 251 (May-June) 1937.

Chiasserini and Neuschüler review the medical and surgical methods of treating retinitis pigmentosa that have been used up to the present. They offer cervical sympathectomy as another possibility for the purpose of altering the choroidal and retinal circulation.

Of the 15 cases reported, improvement occurred in 9, the condition in 5 was unchanged and that in 1 case became worse.

The method has the advantage that not only does it preserve the vision present but it allows for an increase of visual acuity and often of the visual field.

The inconveniences noted were the establishing of the Claude-Bernard-Horner syndrome, hyperemia of the conjunctiva and lowering of the intraocular tension immediately after the operation. With the passage of time all these signs disappeared. A detailed description of the surgical procedure is included. F. P. GUIDA.

BILATERAL LESION OF THE MACULA CAUSED BY RADIATION OF LIGHTNING: REPORT OF A CASE. W. HANDMANN JR., Klin. Monatsbl. f. Augenh. **100:** 438 (March) 1938.

A girl, aged 17, had perfect vision until her eyes were temporarily blinded by lightning. The surface, pupils and media were normal. In each macula a flat, slightly yellowish infiltration was observed, more marked in the left than in the right; these areas were shaped like a geographic map and faintly spotted gray, measuring about 2.5 disk diameters. The disks were free from congestion, and the retinal vessels were normal in appearance but the macular reflexes were absent. Pictures of both fundi are included. Constitutional diseases were excluded by tests in point. Vision increased from 6/18 in the right eye and 6/36 in the left eye to 6/5 and 6/18, respectively, after three weeks' rest in a dark room. After four months vision was nearly 6/5 in each eye, but the central scotoma persisted to some extent.

K. L. STOLL.

THE TREATMENT OF RETINITIS PIGMENTOSA BY LAUBER'S METHOD. I. A. VASSERMAN, Vestnik oftal. **11:** 868, 1937.

Lauber established by clinical and experimental studies that there is a definite relation between the diastolic pressure in the retinal arteries and the intraocular pressure. The decrease of the intraocular tension is favorable for the diastolic pressure and the nutrition of the retina, while the increase of the intraocular tension without a corresponding

increase of the general blood pressure is unfavorable for the circulation of the retina, and an atrophy of the optic nerve or retinitis pigmentosa may result. In order to maintain the normal equilibrium between the diastolic retinal and intraocular pressure, Lauber recommends that the intraocular tension be reduced with the administration of pilocarpine hydrochloride or by cyclodialysis and that the blood pressure be increased by injections of caffein or strychnine.

Vasserman treated 11 patients (21 eyes) from 18 to 51 years of age who were suffering from retinitis pigmentosa, the period of observation being from three to seven months. The functional tests of the eye and measurements of the blood pressure were done before, during and at various times after the treatment. A 2 per cent solution of pilocarpine hydrochloride was instilled into the eye three days preceding the injections. One cubic centimeter of a solution of strychnine in a concentration of 1:1,000 was injected subcutaneously daily up to thirty injections; the pilocarpine hydrochloride was instilled simultaneously.

The intraocular tension and its daily variations were found to be higher in eyes with retinitis pigmentosa than in normal eyes; it was decreased under the influence of miotics, and its daily variation curve was more regular. The blood pressure was low in the majority of the patients. In those patients in whom it could be raised by the injections of strychnine, the therapeutic result was good. The near and distance vision was improved in nearly all patients, while the visual fields were improved in only 3. Recent infections responded to the treatment more readily than the infections which had been neglected.

Vasserman concludes that simultaneous reduction of the intraocular tension and the increase of the blood pressure give favorable results in the treatment of retinitis pigmentosa; further observations are necessary. It was easier to reduce the intraocular tension than to increase the blood pressure.

O. SITCHEVSKA.

Trachoma

PATHOLOGIC APPEARANCE OF THE CORNEA IN TRACHOMA. A. SANTONASTOSO, Ann. di ottal. e clin. ocul. **66:** 401 (June) 1938.

The diagnostic value of corneal changes in trachoma is discussed. The author carefully examined the corneas of many small children with trachoma. Extensive vascularization was found in the corneas of a great number, and in some of the children with mild trachoma vessels passed the limbus. Other children with advanced trachoma were seen, however, in whom there was complete absence of vascularization. On the other hand, vascularization was found in children with slight conjunctivitis without any of the other diagnostic signs of trachoma. The author believes some individual sensitivity of the tissues at the limbus, possibly of an allergic nature, is responsible for the differences observed. He concludes that vascularization of the cornea, while frequent, must not be considered conclusive evidence for or against trachoma but that the diagnosis must be based on other signs and especially on the course of the disease.

S. R. GIFFORD.

Tumors

A Clinical and Anatomopathologic Contribution to Tumors of the Optic Nerve. L. Venco, Ann. di ottal. e clin. ocul. **66**: 321 (May) 1938.

The author reviews the literature and reports a personal case. A boy of 12 years was first seen at the age of 6, when proptosis and loss of vision on the right side had been noticed for two months. Vision in the right eye was 4/50. There was swelling of the disk. Permission for operation was refused, and the patient was not seen till a year later. A tumor the size of a small orange protruded from the orbit, the collapsed and shrunken globe being just visible on its surface. At operation the mass was removed almost intact, a few remains being dissected out piecemeal. Sections showed a swelling of the optic nerve just behind the globe which merged into the tumor mass. This was composed of cells originating from the interstitial cells of the optic nerve but differing in staining properties from both glia and collagen. The tumor is classed as a neurinoma.

S. R. Gifford.

Fibroma of the Sclera. J. Schmidt, Arch. f. Ophth. **138**: 748 (July) 1938.

The author reports the case of a man aged 46 in whom scleritis developed and persisted for about a year, when retinal detachment occurred. The region of the detachment appeared dark on transillumination, and the eye was enucleated. Pathologic examination revealed foci of round cell infiltration in the uvea; a similar but more diffuse infiltration of the sclera at the posterior pole, and a fibroma which had originated from the sclera and, pushing the overlying retina and choroid inward, developed into a large mushroom-shaped intraocular tumor. The author classifies this tumor among the rare primary fibromas of the sclera and considers the inflammatory process to be secondary to the neoplastic one.

P. C. Kronfeld.

Society Transactions

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NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

JAMES W. WHITE, M.D., *Chairman*

Nov. 21, 1938

RUDOLF AEBLI, M.D., *Secretary*

RECURRENCE OF OCULAR HYPERTENSION EIGHTEEN YEARS AFTER AN ELLIOT OPERATION: REPORT OF A CASE. DR. MARK J. SCHOENBERG.

Ocular hypertension recurred in the left eye of a patient eighteen years after an Elliot operation. During this interval the visual acuity remained unchanged and the tension normal. Curves of the ocular tension and visual acuity and records of the visual fields for the entire period of observation were made. (These were projected on the screen.)

DISCUSSION

DR. ARNOLD KNAPP: I think that Dr. Schoenberg's observation is interesting, particularly if there was no change in the filtering scar and the attack of glaucoma responded to treatment with miotics only. I have a case in mind in which the filtering scar ceased to function after eleven years. It occurred to me that this could be due to a change which the patient seemed to be undergoing. There was manifest atrophy of the orbital contents, with sinking in of the eyeballs, such as one would expect in myxedema. The thought came to me that a change in the amount of aqueous filtration might be a possible factor in some of these cases. It is generally known that success in trephining depends on early restoration of the tension, following which a satisfactory bleb is obtained. If the tension is not restored promptly, the bleb is slow in forming and may be inadequate. I believe that in my patient, in whom there was a tendency to myxedema, there was a diminution in the aqueous secretion, so that the filtering scar collapsed and closed up.

DR. ERNEST F. KRUG: I wish to ask Dr. Schoenberg whether during this attack the chamber was very shallow and whether there was any evidence of swelling of the lens.

DR. MARK J. SCHOENBERG: In regard to Dr. Knapp's question, there was no obstruction of the trephine opening; one could clearly see it with the aid of the biomicroscope. I am inclined to believe that the increase of tension was of a "functional nature." The tension would not have yielded so readily to the use of pilocarpine if the trouble had been due to an organic obstruction. I have no doubt that there are several stages in the evolution of ocular hypertension in glaucoma. In

the early stages the increase is functional, and a decrease can be obtained by the administration of pilocarpine. In some cases, as in the one reported by me, the glaucoma may remain in this stage for a considerable length of time.

In reply to Dr. Krug's question, there was no swelling of the lens. Biomicroscopic examination would have revealed this. The anterior chamber was not shallow, and there was no diminution of vision. If there had been swelling of the lens, I do not see how it could disappear after the use of pilocarpine for a few days.

Treatment of Inclusion Conjunctivitis with Sulfanilamide: Report of a Case. Dr. Phillips Thygeson (by invitation).

In view of the curative effect of sulfanilamide in trachoma, it was decided to test the drug on the closely related disease, inclusion conjunctivitis. Accordingly, the drug was given to 2 Macacus rhesus monkeys in which the disease had been produced experimentally. A daily dose of ½ grain (0.032 Gm.) per pound of body weight resulted in complete healing of the lesion in two weeks. There was no change in the conjunctivitis in 2 untreated control animals during this period. The drug was then tested on an adult. The condition was of two weeks' duration, was unilateral and was characterized by severe follicular and papillary hypertrophy of the conjunctiva, most prominent in the conjunctiva of the lower lid. There were preauricular adenopathy, pseudoptosis, bulbar injection and edema of the limbus but no epithelial or other corneal changes. Cultures and scrapings showed no significant bacteria but moderate numbers of epithelial cell inclusion bodies. The patient was hospitalized and placed on a daily dose of 30 grains (0.195 Gm.) of sulfanilamide. No local treatment was employed. Improvement was first noted on the second day, and after thirteen days the eye had returned to normal. Inclusion bodies, which averaged from 15 to 25 per slide at the onset of treatment, could not be found after the second day. The patient has been followed for three months after healing with no evidence of recurrence. In none of 51 previously observed patients (9 adults and 42 infants) with inclusion conjunctivitis who were followed throughout their clinical course did healing occur in less than three months.

DISCUSSION

Dr. Arthur J. Bedell: I can confirm the observations made by Dr. Thygeson. His photographic proof has been duplicated by me. The results following the administration of sulfanilamide are so remarkable that they are almost unbelievable.

I have been using a preparation which combines sulfanilamide with sodium bicarbonate. This is much more concentrated than the usual drug and will soon be on the market.

I was glad to see Dr. Thygeson's pictures, for they speak well for his results. I urge all physicians to try this treatment in properly selected and controlled cases.

Dr. Walter I. Lillie: My experience is similar to that of Dr. Thygeson. I have used the drug only since summer. The first case in which it was employed was very interesting. The patient, a woman

about 54 years of age who had subacute trachoma, on being told that she should discontinue all local measures and take treatment orally, said: "I have been treated in the best clinics in the East for the last eight years, and you are the first physician who has said 'you must discontinue all treatment about the eyes and take the medicine by mouth.'" "Well, madam," I said, "you have given the best clinics in the East a fair trial for eight years and you have not been cured, so if you care to gamble for two weeks you might try this method." She agreed to give the treatment a trial. On the fifth day she telephoned and said: "Doctor, my eyes have felt better the last two days than they have for eight years." When she returned to the clinic, practically all signs of trachoma had disappeared. At the present time she has only a few small active vessels, which appear as a pannus in the upper part of the cornea; the rest of the cornea is clear.

The dose I use is a little different from that used by Dr. Thygeson. For the first week I prescribe a third of the body weight in grains per day in conjunction with the same amount of sodium bicarbonate, and for the second week, a fourth of the body weight in grains. Usually two weeks' treatment more than suffices to eliminate all the acute inflammatory signs. It makes me wonder whether trachoma, as it is seen clinically, is a secondary manifestation of a streptococcic infection, since the streptococcus responds so specifically to sulfanilamide.

DR. RICHARD TOWNLEY PATON: I was much interested in Dr. Thygeson's report, especially since a year and a half ago I began treating some patients with trachoma and severe conjunctivitis. The diagnosis at that time was uncertain, but the ocular condition was becoming progressively worse. I gave numerous subconjunctival injections of a 2.5 per cent solution of prontosil (disodium-4-sulfamidophenyl-2′-azo-7′-acetylamino-1′-hydroxynaphthalene-3′,6′-disulfonate), and I am not yet prepared to say that the method is without danger. I am extremely careful in giving the injections, as there is some danger of damaging the retina. I am favorably impressed with the results obtained in about 15 cases. I wish Dr. Thygeson would tell something about the subconjunctival use of sulfanilamide.

DR. PHILLIPS THYGESON: I have had no experience with the subconjunctival use of sulfanilamide, so I can offer nothing in this connection.

In regard to Dr. Lillie's suggestion of the possibility of the drug acting on a secondary bacterial infection in trachoma, I must say that the sulfanilamide apparently acts directly on the virus. The disease becomes noninfectious for baboons rapidly, which would not be the case if only a secondary bacterial agent were being acted on. Furthermore, the drug causes rapid disappearance of the epithelial cell inclusion bodies, also an indication of direct action on the virus.

TREATMENT OF DISEASES OF THE EYE WITH GRENZ RAYS. DR. RAYMOND PFEIFFER.

This article will appear in full, with discussion, in a later issue of the ARCHIVES.

THE CLINICAL SIGNIFICANCE OF RETINAL CHANGES IN ARTERIAL HYPERTENSION. DR. WALTER I. LILLIE, Philadelphia (by invitation).

Arterial hypertension is a result of some change in the peripheral arteriolar bed which may be functional or organic. The retinal arterioles are the most accessible portion of the peripheral arteriolar bed for observation and study, and ophthalmologists have assumed an important role in aiding the internist to classify arterial hypertension properly by correctly interpreting the associated retinal changes.

These primary changes are observed in the retinal arterioles and may be functional or organic. The functional changes are those that may and do precede permanent organic damage. The rapidity of the hypertensive changes depends on how readily the peripheral arteriolar system responds or compensates to whatever is producing the clinical picture of hypertension. In essential hypertension, if the onset is not too precipitous, the retinal arterioles reveal a generalized constriction or attenuation without any irregularities in the lumen.

If the onset of the hypertension is precipitous, the functional changes observed in the retinal arterioles develop more rapidly and are more severe but may be transitory. Superimposed on the general attenuation or constriction of the arterioles are localized spasms of the arterioles, which in turn, depending on the severity of the spasm, produce an associated localized ischemia of the retina. These changes may be of extremely short duration, and the localized spasm or complete obliteration of the retinal arterioles should not be interpreted as a definite organic change at this stage.

Persistence of the general attenuation or constriction of the arterioles results in damage to the intima, which is revealed as irregularities in the lumen. When this occurs, sclerosis is now superimposed on the already described functional picture, which signifies permanent damage to the peripheral arteriolar system. When generalized attenuation of the arterioles is observed with evidence of sclerosis, graded from I to IV, with the associated widening of the arteriolar reflex stripe and arteriovenous compression, the patient can clinically be classified as having essential or benign hypertension. Associated with these retinal changes, a thrombosis of a branch of the central retinal vein sometimes occurs. This is purely a local change due to excessive compression by a sclerosed arteriole at its venous crossing and should not be confused with the retinitis of hypertension. The hemorrhages and exudates will absorb as soon as a collateral circulation is developed.

The retinal changes of severe hypertension are characterized by the presence of exudates and hemorrhages associated with mild angiospasm of the retinal arterioles, with irregularity of the lumen (sclerosis), widening of the arteriolar reflex stripe and arteriovenous compression but without edema of the disk. The presence of this type of retinitis is significant of severe vascular damage, and both the systolic and the diastolic pressure will be consistently higher than in essential hypertension.

Angiospastic hypertension may be divided into a preorganic and an organic phase. The term angiospasm signifies a narrowing of an arteriole, either partially or completely, to such an extent that it appears

as an ill defined line. When the peripheral arterial bed is precipitously affected without previous organic damage, the fundus presents a picture of edema of the disk and retina with associated cotton wool exudates and hemorrhages, with markedly attenuated and even completely obliterated arterioles but without evidence of sclerosis. Just how long angiospasm can persist without producing permanent damage to the arterioles is not known. If the basic cause can be eliminated before a permanent vascular change takes place, this type of retinitis can improve or may subside without residual vascular damage.

If the precipitous angiospasm is severe enough to produce early vascular damage, or if it is superimposed on a previously damaged peripheral arteriolar bed, the retinitis is characterized by edema of the disk and retina, with associated cotton wool exudates and hemorrhages and definite sclerosis of the retinal arterioles. When this change is observed, the retinitis of malignant hypertension is present. The presence of an incomplete or complete macular star, not infrequently seen in both preorganic and organic angiospastic retinitis, signifies that the retinal edema is absorbing and that the retinitis has been more severe. It does not mean that there is an associated nephritis, as often the renal function is adequate.

The acute retinitis which occurs somewhat precipitously as a terminal complication of glomerulonephritis is attributable to severe secondary anemia which accompanies the renal insufficiency. The disk, retina and choroid are anemic, and the edema, cotton wool exudates and hemorrhages are associated with normal retinal vessels. At times a diffuse edema of the retina accompanies the generalized edema of the body in cases of subacute or chronic glomerulonephritis. This type of retinitis is never seen in essential hypertension.

JAMES W. WHITE, M.D., *Chairman*

Dec. 19, 1938

RUDOLF AEBLI, M.D., *Secretary*

A NEW BINOCULAR GONIOSCOPIC APPARATUS. DR. DONALD BOGART, (by invitation).

The binocular slit lamp microscope has long fascinated inventive-minded ophthalmologists as a gonioscopic possibility. Suitable illumination, a support for the head of the microscope and a contact glass fulfil the requirements for a binocular gonioscope. Therefore, many instruments have been devised, the variable items being the support for the bulky head of the microscope and a source of light. The majority of instruments of this type possess the following disadvantages:

1. They are unwieldy, and the patient is in constant danger of being hit should any of the joints become loose. Most of the instruments hold the head in an upright, unbalanced position.

2. Many operators find it necessary to hold the head in their hands; therefore, high magnification is impossible. The instability of many

upright types of instruments give them but little advantage over the arrangement which is held in the hand.

3. The instruments are all costly.

4. The average busy physician does not have enough time in the routine of his practice to set up the usual bulky devices.

I have, with the help of Mr. Mangold, of Clairmont and Nichols, constructed a satisfactory gonioscopic apparatus in which the microscope is suspended instead of being held upright. Universal rotation and high degrees of magnification are possible. Goniotomy and goniophotography may be practiced, and the patient is in considerably less danger of being hit by the head of the microscope.

The support is made from a photographic copying stand with baseboard, upright and sliding arm, of the type sold by E. Leitz, makers of the Leica camera. The head of the slit lamp is removed, and the bottom joint is drilled to receive the heavy Leica ball and socket tripod head. This in turn is screwed into a small brass rod made to receive it; the rod is held in the end of the aforementioned sliding arm. The head of any standard slit lamp may be used.

Illumination is provided by the lamp used by Dr. Barkan. This is screwed to a rod, which is fitted to any type of head to be used. The lamp is usable on either alternating or direct current and keeps very cool. Any conceivable angle is possible between the objectives and the lamp, which burns at a rated 500 foot candles at its focus. The little lamp may be used as a pocket slit lamp or a transilluminator (suitable heads are available), thereby making up for the fact that its cost of $25 makes it the most costly item in the setup.

The quickly assembled apparatus is set up on a table or chair, with the patient reclining. A pillow is placed on the baseboard, and the ball and socket are centered over the eye to be examined. The entire angle may be explored by the examiner with the ball and socket loose, after the height and angle of the instrument are set. A turn of the setscrew anchors it firmly at any point, and higher power is possible by the substitution of another objective. The patient, whose head acts partially as a counter weight on the baseboard, is cautioned against getting up until the apparatus is steadied. I feel that the setup has the following advantages:

1. The cost is comparatively low. From $45 to $50 will buy the parts.

2. The apparatus is flexible, yet safe and stable enough for high magnification.

3. Illumination is adequate. The lamp may be used as a pocket slit lamp, a transilluminator or a general source of light.

4. The entire setup is easily portable.

5. The interchangeability of parts makes it possible for the owner of a Leica or Contax camera to use the copying stand for the copying of specimens or photographs or for actual photography of the eye in color or black and white, provided he gets the ground glass focusing attachment.

It is to be noted that the cost of parts mentioned does not include the slit lamp head or the contact glass.

I feel that the aforementioned reasons are sufficient excuse for presenting another gonioscopic apparatus. There would be no need for such an instrument (except for goniophotography and for extremely high power magnification) were it possible to obtain an instrument such as that of Dr. Troncoso. The low cost and interchangeability of the parts of the apparatus described make it possible for every ophthalmologist who has access to the head of a binocular slit lamp to possess a satisfactory gonioscope with little embarrassment to his budget or his time.

DISCUSSION

DR. MANUEL URIBE TRONCOSO: I am glad to hear that the method of gonioscopy is receiving more and more attention and that the medical profession is interested in the technic and the results of gonioscopic examination of the eye. To be practical to the clinician, examination of the angle of the anterior chamber has to be made with an instrument that everybody can use. As with the ophthalmoscope, one has to have a gonioscope which is handy, which can be used easily all around the angle and which does not cost too much. When one uses a complicated instrument in which a lot of machinery must be adjusted, a great deal of time is wasted and the contact glass is kept above the eye too long. The contact glass, especially the new, more convex model, is so heavy that it cannot be used for a long time on pathologic eyes. It is alright for normal eyes; a patient can tolerate examination with it for from ten to fifteen minutes, but not if he has glaucoma. In cases of glaucoma associated with hypertension and congestion of the eyeball it is necessary to make the examination quickly to avoid an increase in vascularity.

The objection to all the methods of examination with the slit lamp microscope is that the microscope has to be supported by the hands. As it is too heavy to be supported in this manner during a complete, prolonged observation all around the angle, a stand has to be used. Dr. Barkan, Dr. Hartshorne and, now, Dr. Bogart have devised special stands. The one used by Dr. Barkan which hangs from the ceiling is extremely complicated. The floor stand used by him is similar to the tripod used by Drs. Hartshorne and Castroviejo. Dr. Bogart has inserted a horizontal board under the mattress to hold the supporting shaft. This complicated machinery is alright for purposes of demonstration and for photography of the angle in the normal eye with a deep anterior chamber. However, when the chamber is shallow, especially in pathologic conditions, a convenient manual instrument in which the plane of observation can be changed easily from the surface of the iris to the recess of the anterior chamber is much better and gives more information. Besides, with the slit lamp microscope the illumination system, such as is used in Dr. Bogart's stand, does not follow the movements of the microscope, and the help of an assistant is necessary to focus the beam properly. My own gonioscope, which has a periscopic arrangement, can be turned easily around the center of the eye, and the examination is made quickly. Unfortunately the presence of the prisms makes the focusing of the instrument a little difficult. That is why the instrument has not been popular. I hope in the near future to have another gonioscope made with which one can have direct vision, so that the student and the practitioner may have the advantage of easy

manipulation without prisms. Still, I consider the prism important when the angle is very narrow and I want to see if the recess of the angle is closed or not. With the new contact glass and the gonioscope, one examines the side of the angle close to the observer, not the opposite side. I think that one can keep the instrument on a stand, such as Dr. Hartshorne's or Dr. Bogart's or my own, for purposes of demonstration but that one should have a handy instrument which has good magnification, gives a strong, steady illumination at a proper angle and easily shows the angle all around the eye.

CONGENITAL TYPE OF ENDOTHELIAL DYSTROPHY. DR. FREDERICK H. THEODORE (by invitation).

This article appears in full in this issue of the ARCHIVES, page 626.

ATYPICAL PRIMARY DEGENERATION OF THE RETINA (RETINITIS PIGMENTOSA SINE PIGMENTO): REPORT OF OCCURRENCE IN THREE MEMBERS OF A FAMILY OF FIVE. DR. SAMUEL P. OAST.

Three members of a family of 5 children (all adults) began having night blindness in adolescence. Twins, now aged 27, have so far escaped. The fundi of all 3 are remarkably free from signs of pathologic changes to account for the profound visual disturbance, though some slight evidence of migration of pigment and retinal atrophy are present together with widespread distribution of small whitish dots in the retina, which brings up the subject of retinitis punctata albescens.

The diagnosis of retinitis pigmentosa sine pigmento is made by studies of the visual fields which show the characteristic annular scotomas and peripheral depression of classic retinitis pigmentosa.

DISCUSSION

DR. ARTHUR J. BEDELL: I shall present four fundus photographs in color. Three are of patients suffering from retinitis pigmentosa; in each the zone of pigmentation was remote from the disk and could easily have been overlooked by a hasty observer.

In one patient the disk was of normal color and the retinal vessels were unchanged. In the second, the disk was slightly pallid, both arteries and veins were reduced in caliber, and in the macular region there were small diffuse depigmented areas; 4 disk diameters from the disk a typical zone of deposits the shape of bone corpuscles were seen. In the third, the disk was of a waxy color; the arteries and veins were decidedly contracted, and the pigmentation was marked. In all 3 night blindness was the symptom which led to the investigation.

The fourth picture is the fundus of a young myope whose chief complaint was night blindness, although the fundus showed no pigmentation.

The cases which Dr. Oast presented were of considerable interest, for the patients were examined at a stage when pigmentation was beginning. In all probability a few years from now they will show a decided change. Dr. Oast has performed a real service by reporting these cases, because they will lead to the earlier recognition and diagnosis of retinitis pigmentosa before pigmentation.

CHORIORETINITIS OF THE MACULAR AREA. DR. RAYMOND EMORY MEEK.

When I was requested to give a talk on the diseases of the choroid several years ago, I was extremely bored. I thought that there could be no more uninteresting section of the eye.

I had known that the choroid was a blood vessel coat composed of five layers, the lamina vitrea, or Bruch's membrane, the choriocapillaris, the layer of small blood vessels, the layer of large blood vessels and the lamina fusca, but this seemed all there was to know. In studying the choroid, it proved to be very interesting.

The choroid is the layer which supplies a great part of the nourishment to the interior of the eye. Toxins may readily pass through Bruch's membrane and cause irritation of the retina. It is difficult for cellular exudate and micro-organisms to pass through the membrane and actively attack the retina. It may, however, become permeated with exudate if the inflammation is severe.

Some authorities explain the increase in tension as being a congestion of the choroid with a corresponding increase in volume. Irritation and congestion of the choroidal vessels through stimulation of the sympathetic nervous system may bring this about. The choroid is said to be erectile tissue and to expand readily when congested. This explains why the angle of the anterior chamber is obliterated when a patient has an attack of glaucoma; the sclera, being inelastic, will not give way, and the increased volume inside the eye causes the lens and iris to be pushed forward. This blocks all egress of the fluids of the anterior half of the eye. The attack may cease as rapidly as it began. The shrinking of the choroid allows the lens and iris to sink back, opening the angle and permitting the outflow of the aqueous in the anterior chamber. During repeated attacks, the vessels lose their tone. Thus the choroid remains permanently engorged, and chronic glaucoma is established.

The choroid is necessary to the nourishment of the outer half of the retina; in cases of detachment of the retina the retinal system of vessels may nourish the whole retina for a long time, but slowly the outer half of the retina dies. Hence, the earlier a detached retina is operated on and its double supply of nourishment restored, the more successful the operation is in establishing function.

The choroid is less elastic than the retina, and so in cases of severe contusions of the eye the choroid is ruptured readily and the retina remains intact over it, although the retina may also rupture. Small excrescences or verrucae often develop on Bruch's membrane; these appear as small white dots in the fundus. They are frequently seen in the aged and are spoken of as drusen.

In cases of severe choroiditis the choroid is often destroyed without the retina showing much change. The layer of retinal pigment is dissolved except at the margin of the inflamed area, where it is irritated and proliferates, giving rise to rings of pigment surrounding the choroidal lesion.

In cases of acute miliary tuberculosis the large tubercles may be seen scattered through the choroid; usually three or four are observed,

although as many as seventy-three have been noted. They appear under the retina as large white patches composed of giant cells, and in some areas caseation develops. The surrounding choroid shows little irritation. The retina usually is not involved.

The mesodermal origin of the choroid accounts for its being the seat of development of sarcomas.

I am reporting the case of a patient whom I have observed for about eleven years. When she first consulted me in 1927 she was 36 years of age, well nourished and apparently in good health, but on examining her fundi I found a patch of old healed choroiditis in each eye above and temporal to the disk. At that time a thorough check up revealed nothing of significance but a slightly positive tuberculin reaction. Injections of tuberculin were given, and from time to time since then I have examined the patient but have found no change in the fundus picture. Vision had remained 20/15 in each eye.

On Nov. 6, 1938, the patient consulted me because the vision had been poor in the left eye for two or three weeks. On examination I found the vision to be 20/15 in the right eye, while that in the left eye was limited to ability to distinguish fingers at 4 feet (122 cm.).

The fundus in the right eye showed no change in the patch of choroiditis, but there seemed to be slight edema of the retina over the temporal side and some little white flecks which might be exudate scattered through the macular area.

In the left eye there was an active process around the patch of choroiditis with a new process beginning above it. There was more marked edema of the temporal portion of the retina, and flecks which appeared to be exudate were scattered throughout the macular area.

The patient was put to bed and fever therapy instituted. There was no improvement. Next, sulfanilamide was tried but was discontinued when bile salts appeared in the urine.

A roentgenogram of the sinuses was normal, and a provocative Wassermann test and other tests proved negative, with the exception of the Mantoux test, which gave a 2 plus reaction.

My conclusion was that the condition consisted of a lighting up of an old tuberculous process, and I began injections of tuberculin again. However, rest in bed and the injections were without benefit.

As the patient began to complain of some nasal disturbance, I had Dr. Frank C. Carr see her, although the roentgenograms of the sinuses were normal.

His examination revealed polypoid growths in the nostril with pus coming from the right sphenoid and ethmoid sinuses. He advised immediate operation, which he did on December 2. Within eleven days the vision had returned to 20/200, and the edema appeared to be less in the retina. The patient was feeling better in every way. In fourteen days the vision was 20/50.

The purpose in presenting this case is to show the importance of checking the sinuses and then double checking them. Also, it is too easy to be misguided by a positive tuberculin reaction. Furthermore, an old lesion may mask symptoms and make one think that there is a lighting up of an old process rather than a new infection.

BACTERIAL SYNERGISM IN NECROSIS OF THE LID: REPORT OF A CASE. DR. ISADORE GIVNER.

A man, aged 39, presented himself with a history of an acute infectious process involving the temporal portion of both lower lids ten months previously. At the time of the examination over one third of the outer portion of the lower lid of each eye seemed eaten away, the loss including the cilia, skin, tarsus and mucous membrane. The ulcerated infected area was cleansed, and a culture taken showed a hemolytic Staphylococcus aureus and a facultative aerobic Streptococcus viridans.

Experimentation done with the cultures brought out the observation that 1 cc. of a pure culture of either organism injected alone into the skin of a rabbit produced no reaction, whereas one-half the quantity of each injected together produced marked necrosis of the skin and underlying tissue.

Reconstruction of the lid was finally done by Dr. W. Hughes after his method of reconstruction on the lower lid, and an excellent result ensued.

THE FUNDUS EVIDENCE OF OCULAR INJURY. DR. ARTHUR J. BEDELL, Albany, N. Y.

Eighty colored photographs of fundi will be presented as the basis for the demonstration of lesions of the fundus following trauma. Perforations of the eyeball and intraocular foreign bodies are excluded; only the visible signs of injury to the fundus are presented. The prognosis in any accident should be withheld until the details of the fundus become visible.

DISCUSSION

DR. MORRIS DAVIDSON: These pictures may mislead one and give a wrong idea as to the extent of changes in the fundus from injuries. They are only photographs of injuries at the posterior pole. Most injuries, however, are in the periphery of the fundus. Such injuries, of course, are not accessible to photography.

I should like to challenge Dr. Bedell's unjustified statement about workmen's compensation. He does not deal with so-called compensation courts alone; he also deals with state ophthalmologists in the courts, who are impartial and who protect equally the claimant's and the insurance carrier's interests. No, Dr. Bedell does not deal solely with compensation courts.

DR. ARTHUR J. BEDELL: I disagree with the statement last made. I believe that when one goes before a referee who is legally appointed to receive evidence that one is to all intents and purposes in a court. I am afraid that Dr. Davidson would like to make me believe that I, as a witness, should agree or disagree with the physicians employed by the state. My function is to present what I believe is true evidence and to make deductions based on the facts.

Dr. Davidson says that most of the lesions following trauma are in the periphery of the fundus. If they cannot be seen through the photographing ophthalmoscope, the camera, and few are examined pathologically, on what can he base his assertion?

DR. MORRIS DAVIDSON: I did not say that the majority of these lesions are in the periphery of the fundus as the result of guess work. I am speaking of lesions in the periphery of the fundus which are visible on indirect ophthalmoscopic examination. They are not often visible on direct ophthalmoscopic examination. Furthermore, these lesions in the periphery of the fundus are part of the well known traumatic syndrome of the anterior segment, in which the nature of the lesions in the fundus is vouched for by accompanying lesions in the iris, lesions in the equator of the lens, i. e., opacities and pigment in the vitreous, and chorioretinal lesions, i. e., pigmented scars in the extreme periphery of the fundus, very often close to the ora serrata, which are visible on indirect ophthalmoscopic examination; so that this is not guess work. The lesions are actually there. In addition, there are partial scleral ruptures which might be described as giving rise to lesions in the periphery of the fundus which are likely to be missed but which can be seen and verified by examining the sclera.

DR. ARTHUR J. BEDELL: The only thing to be gotten from Dr. Davidson's reply is that there is pigmentation at the periphery. Surely this is not a new fact, for I have shown slides demonstrating it at this meeting.

DR. MORRIS DAVIDSON: I wish Dr. Bedell would study such lesions and attempt to photograph them.

DR. ARTHUR J. BEDELL: I do not think Dr. Davidson is justified in stating that the majority of traumatic injuries to the fundus are outside the posterior pole. I do not think that is borne out by the experience of most ophthalmologists.

DR. MORRIS DAVIDSON: It is borne out by a study of mine reported under the title of "The Minor Sequelae of Eye Contusions." I recorded the incidence of lesions of the posterior pole and the incidence of lesions of the peripheral portion of the fundus, and the latter amounted to about 58 per cent.

DR. ARTHUR J. BEDELL: I am sure that Dr. Davidson and I could carry this on endlessly without benefit to the listeners.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

EDWARD STIEREN, M.D., *President*

Jan. 23, 1939

GEORGE H. SCHUMAN, M.D., *Secretary*

LOUIS W. STATTI, M.D., *Reporter*

GLIOMATOSIS OF THE OPTIC NERVE: REPORT OF A CASE. DR. ROBERT J. BILLINGS.

Mrs. J. T., aged 48, an Italian housewife, a brunette, was first seen on Oct. 30, 1937, complaining of blindness in the left eye. There was a

history of an accidental blow five years before but with no immediate symptoms or effects. Two years ago she noticed dimness of vision in the eye and the appearance of black spots before it, which increased in number and gradually formed into a dark black mass. There was no history of hereditary disease. She had had high blood pressure for the past several years (193 systolic and 110 diastolic). The Wassermann reaction was negative. The general physical examination otherwise gave negative results, and the laboratory findings were essentially negative.

The vision of the right eye was 6/9, corrected to 6/6 with glasses, and the eye showed no abnormal changes externally or internally.

The left eye could perceive only hand movements at the extreme temporal periphery of the visual field. The cornea was clear; the iris was heavily pigmented, brown and healthy in appearance, and the pupil was 5 mm. in diameter. It reacted sluggishly to light and dilated freely but unevenly under cycloplegia with homatropine hydrobromide. Back of the lens there was an opaque brownish mass, about 5 by 8 by 12 mm., lying in the anterior portion of the vitreous chamber, with its flat side against the temporal wall of the globe. Deep oblique illumination of the angle showed a flat bright red mass back of the lens, which was believed to be a recent hemorrhage. No fundus details were visible on ophthalmoscopic examination. The slit lamp revealed a furry gelatinous surface to the mass and many red blood cells in the anterior vitreous. Transillumination and Wheeler's sign were positive for a globe impervious to light except for a narrow superior zone. The intraocular tension was 30 mm. (Schiötz). A provisional diagnosis of sarcoma was made, and the case was presented before the Pittsburgh Ophthalmological Society on Nov. 23, 1937, where it aroused considerable discussion. Enucleation was deemed advisable because of the possibility of a malignant growth, and was performed on Dec. 3, 1937, with the patient under a general anesthesia. Convalescence was uneventful.

The diagnosis based on macroscopic and microscopic examination of the specimen was: a large, organized hemorrhage in the vitreous; a smaller, more recent hemorrhage in the vitreous; retinal arteriosclerosis; degeneration of the retinal ganglion cells; melanosis, and, most surprisingly, gliomatosis of the optic nerve.

EXFOLIATION OF THE ANTERIOR CAPSULE OF THE LENS. DR. JAY G. LINN.

Two women, both over 60 years of age, presented a senile flaking of the anterior capsule of the lens in both eyes. In each case no other pathologic change was noted except a slight elevation of tension in one and vascular sclerosis in the other. Dr. Stieren pointed out the close relationship of exfoliatio lentis to glaucoma by calling attention to the following statistics presented by Horven in 1936: Of 43 patients with flaking, 40 had glaucoma, and of 150 patients with glaucoma, 128 had flaking. Trauma to the iris as a causative factor was brought out when it was noted that in a similar case exfoliation of the capsule of the lens did not occur at the point where iridectomy had been performed. The use of miotics was suggested to immobilize the iris and prevent rubbing of the anterior capsule.

Loss of Vitreous. Dr. Edward A. Weisser.

A man, aged 39, had his left eye enucleated in 1933 for phthisis bulbi following trauma. In 1937 his right eye presented a mature cataract, and extraction was advised. At completion of the corneal section there was an immediate and rapid flow of liquid vitreous. The speculum was quickly removed and the eye closed for about five minutes. At the end of this time, with the lids held open by retractors, iridectomy was performed and the lens delivered with the aid of a wire loop, with slightly more loss of vitreous. Sterile warm physiologic solution of sodium chloride was injected into the globe with a pipet. No attempt was made to replace the pillars of the iris. A binocular bandage was applied, and the usual postoperative management was carried out. At the first dressing there was little postoperative injection; the anterior chamber was fairly well reformed, and the corneal wound, flap and pillars of the iris were in good position. The patient left the hospital at the end of two weeks with vision of 6/60. He returned home to the northern part of the state to the care of the referring ophthalmologist. Recently this ophthalmologist reported that the patient sees fairly well and is able to do odd jobs about the house and to go out alone.

Aniridia. Dr. Charles Kutcher.

Aniridia occurred in 3 members of the same family, the mother, aged 47; a son, aged 7, and a daughter, aged 9. There was no history of consanguinity, nor were any other members similarly afflicted. All 3 persons had posterior cortical cataracts; in addition, the mother had microphthalmos of one eye, and 1 of the children had corneal opacities. Two other daughters in the same family had normal eyes.

Retraction Syndrome. Dr. John S. Plumer.

A man presented a typical Duane retraction syndrome in the right eye, which as a rule occurs in the female sex. Uncorrected vision in the right eye was 6/15 and in the left eye, 6/7.5. The ocular fundi show no pathologic changes.

Retinal Detachment. Dr. Louis W. Statti.

E. S., aged 16, was struck in the right eye by a mushball in January 1937. Since then he had had a gradual decrease in vision. Examination six months later revealed a large retinal detachment, which included the entire lower half of the retina and the macular area. There was a large triangular retinal tear at 5 o'clock in the periphery, with the base extending toward the ciliary body. Vision was limited to perception of hand movements, and there was a corresponding defect in the visual field. The left eye was normal.

On June 9, 1937, electrocoagulation was carried out. The sclera was exposed over the entire lower half of the globe; the muscles were not resected. A single point needle about 2 mm. in length was used, and after the area above the tear was encircled with single punctures, extending through the sclera and the choroid, the remainder of the exposed sclera was punctured about fifteen times, several points reaching back as far as the equator. A mixed cutting and coagulating current

was used. The operation was repeated about two weeks later; at this time the punctures were localized over the lower nasal quadrant, owing to the fact that the retina was still detached at this point. Recovery was uneventful.

One month after operation vision in the right eye was 20/70, and the field was normal. At the time of this report vision is 20/30, and the retina is completely reattached.

Book Reviews

Anatomie der Sehrinde (Monographie aus dem Gesamtgebiet der Neurologie und Psychiatrie, no. 64). By Prof. Max de Crinis. Price, 7.80 marks. Pp. 37, with 19 illustrations. Berlin: Julius Springer, 1938.

By a special staining method de Crinis has succeeded in demonstrating the ganglion cell bodies and the dendrites together, as with Golgi's method. He believes that the development of the dendrites expresses the higher or the lower functional value of a ganglion cell. He shows this in the visual cortex (as was done a few years ago in the auditory cortex) and gives a brief survey of the anatomy of this part of the brain. He describes the well known features about the extension of the cortical visual field in man and in animals. In the lower forms it is lateral, while in the higher forms it is located more medially. The extension of this visual field from the calcarine fissure to the lateral surface of the brain in man characterizes a higher type with a special development of the visual sense (see the brain of the painter Menzel). An accurate description of the cytoarchitecture, myeloarchitecture and angioarchitecture confirms for the most part the findings of Brodmann and of von Economo and Koskinas.

The author denies the existence of the coniocortex (powder-like cortex) of von Economo and Koskinas, because he found many dendrites on the cells in area 17, or Oc (calcarina). He could also distinguish, like Henschen, light and color sense cells. He agrees with Kleist that in the fourth layer of the calcarina there is a correspondence of the inner part with the contralateral region of the outer part and with the homolateral fibers of the optic radiation. The intermediate layer may link together the impressions of both fields. He describes in the same manner the other two areas (18 and 19, or Ob and Oa of von Economo and Koskinas), the parastriatal and peristriatal areas, with the disappearance of the special visual cells. The primary function of light and color vision is located in the calcarina. The so-called visuopsychic functions (mnestic, associative or opticomotor) are located in the parastriatal and peristriatal fields. These develop later than the calcarina, according to the dendrites (theory of cytodendrogenesis). Descriptions of the myeloarchitecture and angioarchitecture are cited only from papers by Vogt, Kawata and Pfeiffer.

OTTO MARBURG.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. 1.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. H. G. Ditroi, Szeged.
Assistant Secretary: Dr. Stephen de Grosz, University Eye Hospital, Maria ucca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

Ophthalmological Society of Egypt

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

Ophthalmological Society of the United Kingdom

President: Mr. T. Harrison Butler, 81 Edmund St., Birmingham, England.
Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1, England.
Time: April 20-22, 1939.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Oxford Ophthalmological Congress

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Time: July 6-8, 1939.

Palestine Ophthalmological Society

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

Polish Ophthalmological Society

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

Royal Society of Medicine, Section of Ophthalmology

President: Dr. Malcolm Hepburn, 111 Harley St., London, W. 1, England.
Secretary: Dr. C. Dee Shapland, 15 Devonshire Pl., London, W. 1, England.

Société Française d'Ophtalmologie

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

Society of Swedish Ophthalmologists

President: Prof. K. G. Ploman, Stockholm.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö.

Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

Tsinan Ophthalmological Society

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung, China.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. S. Judd Beach, 704 Congress St., Portland, Maine.
Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.
Place: St. Louis. Time: May 15-19, 1939.

American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Chicago. Time: Oct. 8-13, 1939.

American Ophthalmological Society

President: Dr. Frederick Tooke, 1482 Mountain St., Montreal, Canada.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Place: Hot Springs, Va.

Canadian Medical Association, Section on Ophthalmology

President: Dr. S. Hanford McKee, 1528 Crescent St., Montreal.
Secretary-Treasurer: Dr. J. A. MacMillan, 1410 Stanley St., Montreal.
Place: Montreal. Time: June 19-23, 1939.

National Society for the Prevention of Blindness

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. R. O. Ebert, 104 Main St., Oshkosh.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Oshkosh. Time: May 1939.

New England Ophthalmological Society

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. F. C. Cordes, 384 Post St., San Francisco.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: San Francisco. Time: June 19-22, 1939.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. Edward Clark, 1305–14th Ave., Seattle.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

Rock River Valley Eye, Ear, Nose and Throat Society

President: Dr. L. J. Friend, 425 E. Grand Ave., Beloit, Wis.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501–7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. Don M. Howell, Alma, Mich.
Secretary-Treasurer: Dr. Louis D. Gomon, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

Sioux Valley Eye and Ear Academy

President: Dr. R. A. Kelly, 304 N. Main St., Mitchell, S. D.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

Southwestern Michigan Triological Society

President: Dr. Carl Wencke, Battle Creek.
Secretary-Treasurer: Dr. A. K. Zinn, Battle Creek.
Time: Third Thursday of alternate months.

Western Pennsylvania Eye, Ear, Nose and Throat Society

President: Dr. C. M. Harris, Johnstown.
Secretary-Treasurer: Dr. C. Wearne Beals, 41 N. Brady St., DuBois.

STATE

Colorado Ophthalmological Society

President: Dr. Edward Jackson, 1008-A Republic Bldg., Denver.
Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.
Place: University Club, Denver. Time: 6:30 p. m., third Saturday of each month, October to April, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. William M. Good, 63 Center St., Waterbury.
Secretary-Treasurer: Dr. S. J. Silverberg, 201 Park St., New Haven.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. Grady E. Clay, 384 Peachtree St., N. E., Atlanta.
Secretary-Treasurer: Dr. J. Mason Baird, 511 Medical Arts Bldg., Atlanta.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.
Place: Indianapolis. Time: First Wednesday in April.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.
Place: Davenport.

Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. Francis E. Le Jeune, 632 Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.
Place: Gulfport, Miss. Time: May 8, 1939.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. B. Fralick, 201 S. Main St., Ann Arbor.
Secretary: Dr. O. McGillicuddy, 124 W. Allegan St., Lansing.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. Frank N. Knapp, 318 W. Superior St., Duluth.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. Roy Grigg, Bozeman.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. Norman W. Burritt, 30 Beechwood Rd., Summit.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark.
Place: Atlantic City. Time: June 1939.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Algernon B. Reese, 73 E. 71st St., New York.
Secretary: Dr. Chester C. Cott, 333 Linwood Ave., Buffalo.

North Carolina Eye, Ear, Nose and Throat Society

President: Dr. F. C. Smith, 106 W. 7th St., Charlotte.
Secretary-Treasurer: Dr. M. R. Gibson, Professional Bldg., Raleigh.
Place: Statesville. Time: Sept. 21, 1939.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. N. A. Youngs, 322 De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, 516–6th St., Valley City.
Place: Fargo. Time: May 1939.

Oregon Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. O. Clement, 406 State St., Salem.
Secretary-Treasurer: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

Rhode Island Ophthalmological and Otological Society

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

South Carolina Society of Ophthalmology and Otolaryngology

President: Dr. S. B. Fishburne, 1430 Marion St., Columbia.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

Tennessee Academy of Ophthalmology and Otolaryngology

President: Dr. J. B. Stanford, 899 Madison Ave., Memphis.
Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg., Memphis.

Texas Ophthalmological and Oto-Laryngological Society

President: Dr. A. N. Champion, 705 E. Houston St., San Antonio.
Secretary: Dr. Dan Brannin, 1719 Pacific Ave., Dallas.
Place: Houston. Time: December 1939.

Utah Ophthalmological Society

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.
Secretary-Treasurer: Dr. M. H. Williams, 30½ Franklin Rd., S. W., Roanoke.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. Andrew Rados, 31 Lincoln Park, Newark.
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. L. E. Brown, Second National Bldg., Akron, Ohio.
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron, Ohio.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. Arthur G. Fort, 478 Peachtree St., N. E., Atlanta, Ga.
Secretary: Dr. Lester A. Brown, 478 Peachtree St., N. E., Atlanta, Ga.
Place: Grady Hospital. Time: 6:00 p. m., second Wednesday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
Secretary: Dr. Fred M. Reese, 6 E. Eager St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. N. E. Miles, 408 Medical Arts Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. E. Clifford Place, 59 Livingston St., Brooklyn.
Secretary-Treasurer: Dr. Frank Mallon, 1135 Park Pl., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
Secretary-Treasurer: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park, Ill.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

Cleveland Ophthalmological Club

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. Hugh G. Beatty, 150 E. Broad St., Columbus, Ohio.
Secretary-Treasurer: Dr. W. A. Stoutenborough, 21 E. State St., Columbus, Ohio.
Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
Time: Second Thursday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Maxwell Thomas, Medical Arts Bldg., Dallas, Texas.
Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Arthur S. Hale, 1609 Eaton Tower, Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. L. A. Hulsebosch, 191 Glen St., Glen Falls.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. R. A. Gough, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Charles R. Lees, 806 Medical Arts Bldg., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Louis Daily, 1215 Walker Ave., Houston, Texas.
Secretary: Dr. Herbert H. Harris, 1004 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. J. K. Leasure, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to June.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. E. N. Robertson, Concordia, Kan.
Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Paul Nilsson, 211 Cherry Ave., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gaylord C. Hall, Brown Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Charles K. Beck, Starks Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.
Secretary: Dr. Elmer Shepherd, 1606–20th St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. John E. Mulsow, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.
Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.
Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. P. H. Kilbourne, Fidelity Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. L. de G. Joubert, 690 Dunlop St., Montreal, Canada.
Secretary: Dr. K. B. Johnston, 1509 Sherbrooke St., W., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Guy Maness, 119–7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. E. G. Walls, 619 Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. James W. White, 15 Park Ave., New York.
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Percy Fridenberg, 38 W. 59th St., New York.
Secretary: Dr. David Alperin, 889 Park Pl., Brooklyn.
Place: Squibb Hall, 745–5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. Philip Romonek, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Ophthalmological Society of the University of Pittsburgh

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Time: Second Monday in November, January, March and May.

Passaic-Bergen Ophthalmological Club

President: Dr. R. N. Berke, 430 Union St., Hackensack, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

Chairman: Dr. Walter I. Lillie, 255 S. 17th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward Stieren, Union Trust Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Rudolph Thomason, Professional Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

President: Dr. Edwin S. Ingersoll, 26 S. Goodman St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.
Place: Rochester Academy of Medicine, 1441 East Ave. Time: 8 p. m., second Wednesday of each month from September to May.

St. Louis Ophthalmic Society

President: Dr. B. Y. Alvis, Carleton Bldg., St. Louis.
Secretary: Dr. Carl C. Beisbarth, 3720 Washington Blvd., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. R. R. Kirkpatrick, 6th and Walnut Sts., Texarkana, Ark.
Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. P. B. Greene, 422 Riverside Ave., Spokane, Wash.
Secretary: Dr. O. M. Rott, 421 Riverside Ave., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. James F. Cahill, 428 S. Salina St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. A. Lloyd Morgan, 170 St. George St., Toronto, Canada.
Secretary: Dr. W. R. F. Luke, 170 St. George St., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.